DOCUMENT RESUME

ED 277 822 CE 045 749

AUTHOR	Johnson, Dennis; And Others
TITLE	Electronics Book II.
INSTITUTION	Elk Grove Unified School District, Calif.
PUB DATE	Sep 86
NOTE	458p.; For books 1 and 3, see CE 045 748 and CE 045 750.
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC19 Plus Postage.
DESCRIPTORS	Adult Education; Behavioral Objectives; *Bilingual Education; Curriculum Guides; *Electricity; *Electronics; English (Second Language); Lesson Plans; Postsecondary Education; Program Design; Second Language Instruction; *Trade and Industrial Education; *Vocabulary Development; Vocational Education; *Vocational English (Second Language)

ABSTRACT

This manual, the second of three curriculum guides for an electronics course, is intended for use in a program combining vocational English as a second language (VESL) with bilingual vocational education. Ten units cover the electrical team, Ohm's law, Watt's law, series resistive circuits, parallel resistive circuits, series parallel circuits, magnet, generators and motors, ac/dc electricity, and instrumentation. A lesson plan is provided for each lesson within the unit. Components include teaching materials sources, main concepts (objectives), teaching activities, materials and notes, length of lesson, and evaluation. Other contents of each unit include handouts, such as informational material, homework/assignments, lab experiments, unit tests, glossaries of technical and related general vocabulary, and Vietnamese and Cantonese translations. Numerous drawings and diagrams illustrate the text. (YLB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED277822

ELECTRONICS BOOK II

Dennis Johnson
David Thompson
Song Hahn
Lani Hahn

Elk Grove Unified School District
Elk Grove, CA

September 1986

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it

☐ Minor changes have been made to improve reproduction quality

- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

L Ward

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

CE045749

BEST COPY AVAILABLE

ELECTRONICS

BOOK II

UNITS

I.	THE ELECTRICAL TEAM	1-2 weeks
II.	OHM'S LAW	1 week
III.	WATT'S LAW	1 week
IV.	SERIES RESISTIVE CIRCUITS	2 weeks
V.	PARALLEL RESISTIVE CIRCUITS	1 week
VI.	SERIES PARALLEL CIRCUITS	3 weeks
VII.	MAGNET	1 week
VIII.	GENERATORS AND MOTORS	[illegible]
IX.	AC/DC ELECTRICITY	[illegible]
X.	INSTRUMENTATION	

SECTIONS

1. Lesson Plan
2. Teaching Materials
3. Homework/Assignments
4. Lab Experiments
5. Tests
6. Technical Glossary
7. Related General Glossary
8. Vietnamese Translations
9. Cantonese Translations

ELECTRO URRICULUM
VOCATIONAL TRAININ SSON PLAN # I The Electrical Team

Teaching Materials Source ______________________________
Chapter ____________, pages ______________
Lab Manual pages ______________
Additional Instructor Materials ______________________________

Main concepts student will learn:

The student will be able to:

1. identify and differentiate between the basic types of electrical quantities and their corresponding units of measurements.
2. compare and contrast the application of meters used in measuring simple electrical quantities.
3. demonstrate the proper techniques to employ when reading a typical meter scale, and to explain the necessity of an accurate measurement.

Technical Vocabulary

see Glossary

Related General Vocabulary

Materials and Notes

Teaching Activity

1. Be aware when explaining simple terminology that very often first exposure to technical expressions can be misunderstood by the student. Spend a significant amount of time reviewing what these terms, voltage, current, and resistance mean, then briefly explain their relationship with each other.

   Meters and measurement are vital instructional concepts especially for future laboratory work so it is worthwhile to; re-imphasize major instructional points periodically, illustrate methods of meter connections, utilize managers or advance students to assist in supervision and instruction, and coordinate measurement activities so that electrical quantities are not measured in succession.

Length of Lesson

1 - 2 weeks

Evaluation

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of oral or written testing procedures.

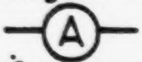
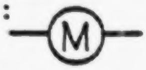
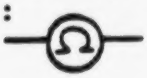
Name: ____________________

Date: ____________________

Period: ____________________

ELECTRICAL TEAM

TECHNICAL GLOSSARY

AMMETER:	An instrument designed to measure electrical current flow. Symbol: 
AMPERE:	The basic unit of measurement for current flow. Letter symbol: A
CURRENT:	The orderly flow of electrons through a circuit. Current is measured in the basic unit amperes or amps. However, milliamperes and microamperes are also used as units of measurement. Letter symbol: I
DEFLECTION:	The movement of the meter pointer from the zero position.
DIGITAL MULTIMETER:	A multimeter whose input or measured value is displayed directly as illuminated digits or numbers. Abbrev. DMM
ELECTROMOTIVE FORCE:	The pressure that causes electrons to move through a circuit and also referred to as voltage. Letter symbol: E, Abbrev: EMF
FUNCTION SWITCH:	A meter control used to select the electrical quantity (voltage, current, or resistance) to be measured.
INFINITY:	An extremely large value that continues indefinitely. Symbol:
MECHANICAL ZERO:	An adjustment to the meter movement which mechanically sets the meter pointer on zero. This adjustment is necessary for accurate measurement.
METER:	A device to measure electrical quantities; such as voltage, resistance, frequency, etc. Symbol:  Letter symbol: M
MULTIMETER:	A meter designed to measure more than one electrical quantity. Most multimeters can measure AC and DC voltage, AC and DC current, and resistance.
NEEDLE:	The indicating device on a meter, sometimes called the pointer. The needle and scale are used in conjunction to read the indicated value.
OHM:	The basic unit of measurement for resistance. Letter symbol: Ω
OHMMETER:	An instrument used to measure electrical resistance in ohms. Symbol: 

Name: ____________________

Date: ____________________

Period: ____________________

POLARITY:	The property of a device or circuit determining the direction in which current flows. The quality of having two opposite charges, one positive (+) and the other negative (-). Polarity can also refer to the quality of having two opposite magnetic poles, one north and one south.
RANGE SWITCH:	A basic meter control used to select the maximum value which the meter can measure. Many times the range switch is used as a multiplier.
RESISTANCE:	A measure of the opposition that a component or circuit offers to the flow of an electric current. Resistance is measured in the basic unit ohms, however kilohm, and megohms are also used as units of measurement. Letter symbol: R
SCALE:	Line or arc found on an instrument face with graduations or increments that have an assigned value.

CURRENT
OHMS - RESISTANCE
I
CURRENT - AMPERES
E
AMPERES
VOLTS - VOLTAGE
R
Ω
Ω
OHMS

Name: ____________________

Date: ____________________

Period: ____________________

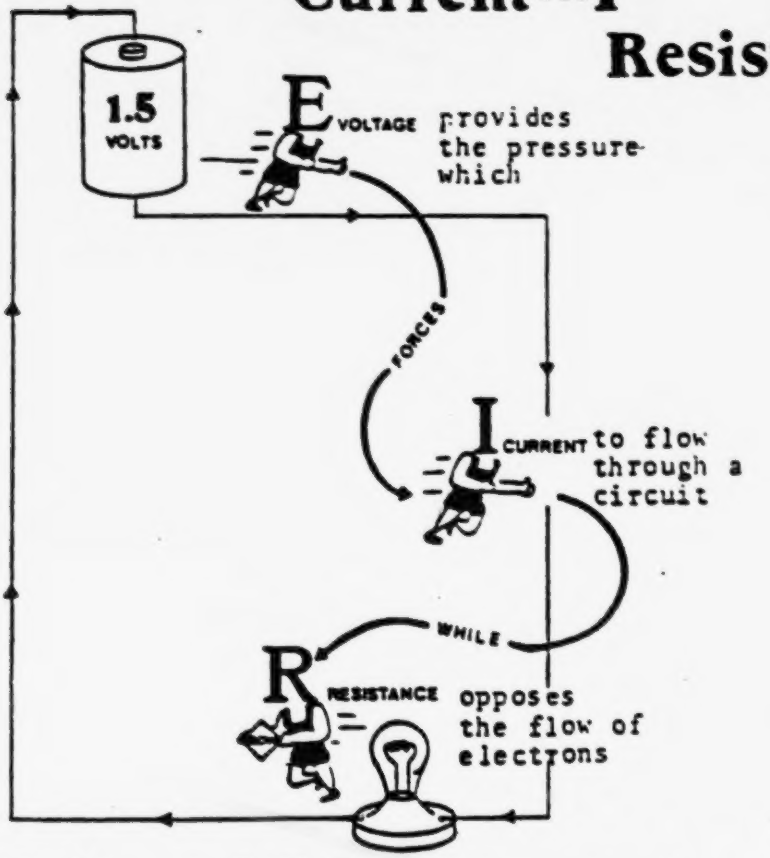
INFORMATIONAL HANDOUT

THE ELECTRICAL TEAM

Voltage…E

Current…I

Resistance…R


1.5 VOLTS
E VOLTAGE provides the pressure which
FORCES
I CURRENT to flow through a circuit
WHILE
R RESISTANCE opposes the flow of electrons

Units of Measurement

Voltage is measured in the basic unit *volts* (V)

Current is measured in the basic unit *amperes* (A)

Resistance is measured in the basic unit *ohms* (Ω)

Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

PROCEDURES IN READING A METER

The sequence below should be utilized as a reference guide when reading a meter.

1. CHECK THE FUNCTION SWITCH.

   Determine what quantity is being measured.

2. LOCATE THE METER SCALE.

   Find the scale that matches the quantity set on the function switch.

3. READ THE SCALE.

   Read the value where the pointer comes to rest across the scale divisions. Be sure you are looking directly at the scale to avoid parallax problems.

4. CHECK THE RANGE SWITCH.

   Identify the range position, then determine the multiplier.

5. MULTIPLY THE SCALE READING.

   Multiply the reading on the scale by the multiplier indicated by the range switch.

6. THAT'S ALL THERE IS TO IT - YOU HAVE READ THE METER.

   When you record the value you have read, be sure to also record the quantity measured - volts, ohms, or amperes.

4

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

HOW TO USE A METER TO MEASURE VOLTAGE OR RESISTANCE

1. SET THE FUNCTION SWITCH

Adjust the function switch for the electrical quantity you want to measure.

Identify the quantity being measured - DC voltage, AC voltage, or resistance - and select the one proper function switch position.

2. SET THE RANGE SWITCH

Caution must be used when setting the range switch. When using the voltage functions be sure the range switch is set in a high enough position so you will not peg the meter.

HINT: If measuring an unknown value of voltage set the range switch to the highest position.

In the ohms function, the range position is not critical. Select the position that will move the pointer closest to mid-scale.

3. ZERO THE METER

Be sure to zero the meter. This will insure an accurate measurement.

ZEROING PROCEDURE:

a. If available, adjust the "mechanical zero" so that the meter indicates zero. This adjustment is made when the meter is off.

b. Zeroing for voltage. Turn the meter on, and allow enough time for stabilization. Connect the test leads together, and use the zero adjust control to set the indicator to zero.

c. Zeroing for resistance. After your meter has stabilized, connect the test leads together and adjust for zero resistance with either the zero adjust or ohms adjust (depending upon the type of meter). Disconnect leads and adjust for infinity. The last two steps may have to be repeated to achieve accurate zeroing.

4. CONNECT THE METER INTO THE CIRCUIT

A. Voltage connection

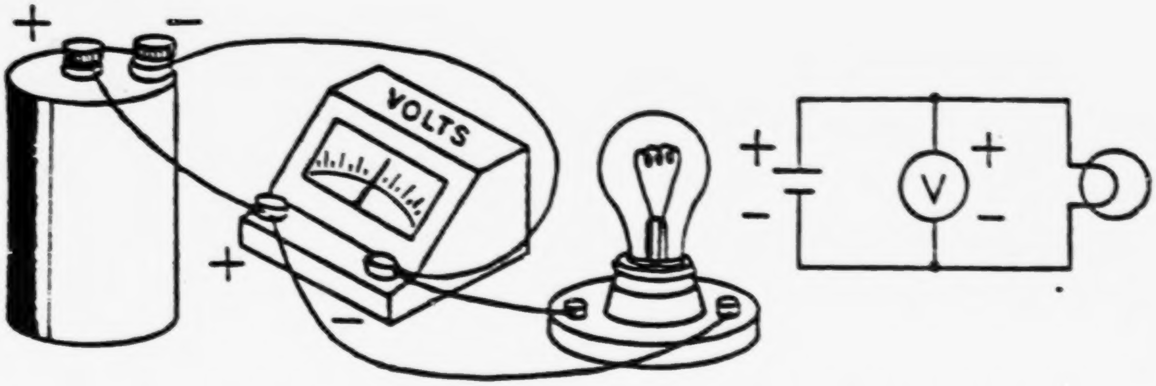
When measuring voltages (AC or DC) the meter must be connected in parallel with the circuit.

Name: ____________________

Date: ____________________

Period: ____________________

Also, be sure to observe polarity when measuring DC voltages - the positive lead of the meter must be connected to the positive side of the circuit. The negative lead must be connected to the negative side of the circuit.



NOTE:

If the reading is below the usable portion on the voltage scale the range switch may be stepped down one position for a more accurate reading.

B. Resistance connection

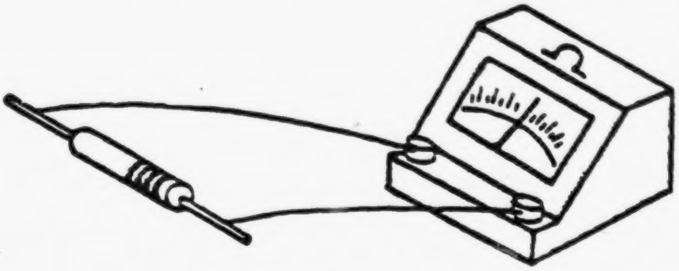
When measuring resistance the meter must be connected in series with the resistance being measured.

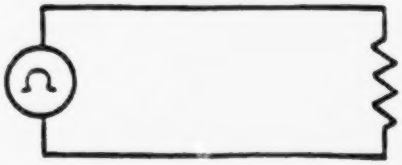
Be sure that there is no power applied to the circuit when measuring resistance.

The best way to accurately measure the resistance of a resistor is to remove it from the circuit.

The ohm meter is a valuable instrument for checking continuity of both components and circuits.

Polarity need not be observed in this kind of measurement.





NOTE:
An accurate reading will be achieved if the needle is close to the middle of the scale. Vary the range switch to locate the position where the pointer moves closest to the center scale.

Name: ______________________

Date: ______________________

Period: ______________________

5. READ THE METER

Read the value indicated on the meter. Refer to your handout - "Steps in Reading a Meter" for step by step procedure.

6. TROUBLESHOOTING HINTS

a. Common causes of meter malfunctions.
   1) open or damaged test leads
   2) weak or dead batteries
   3) blown fuse or reset
   4) damaged meter circuit
   5) improper meter connection

b. Be sure to recheck your zero adjustments if you have changed the function or range switch.

c. CAUTION - do not touch the metal tips on the test leads when making measurements.

d. Double check all connections before turning on power or taking measurements.

SCORE:

GRADE:

Name: ________________

Date: ________________

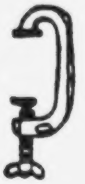
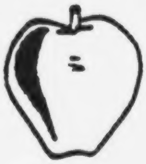
Period: ________________

WORKSHEET

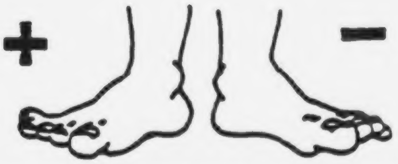
GLOSSARY CRYPTICS

Decode the cryptic messages below to identify the electronic term.

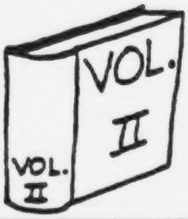
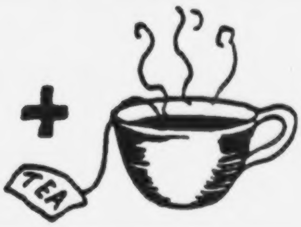
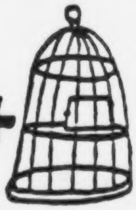
EXAMPLE:

A. **X** +  -Cl +  -Ap

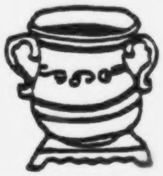
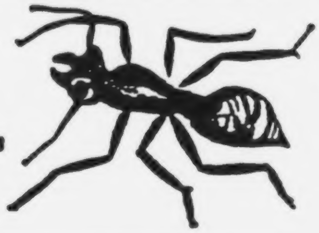
A. EXAMPLE

1. **M** +  - F + R

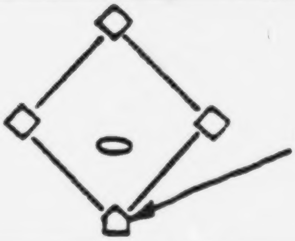
1. ☐

2.  +  +  - C

2. ☐

3. **C** +  - N + 

3. ☐

4.  - h - plate

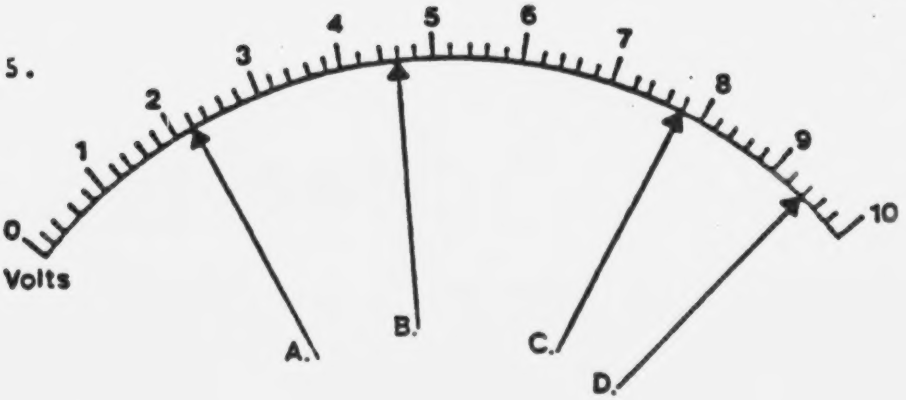
4. ☐

Name: ____________________

Date: ____________________

Period: ____________________

5.


0
1
2
3
4
5
6
7
8
9
10
Volts
A.
B.
C.
D.

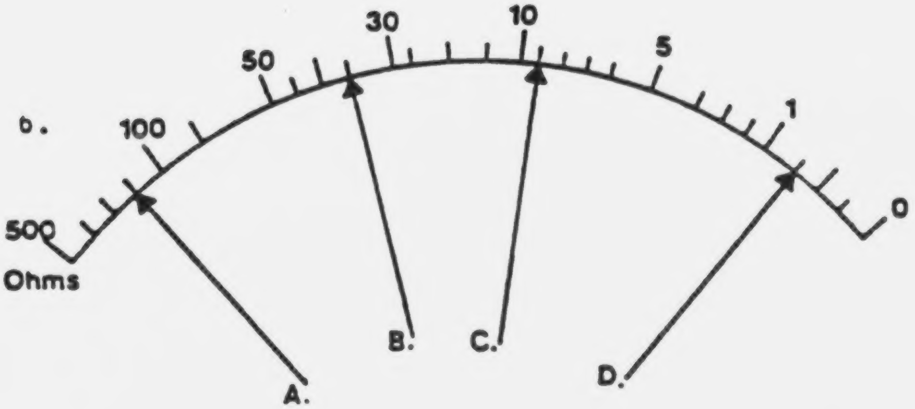
5A. ☐

5B. ☐

5C. ☐

5D. ☐

6.


500
100
50
30
10
5
1
0
Ohms
A.
B.
C.
D.

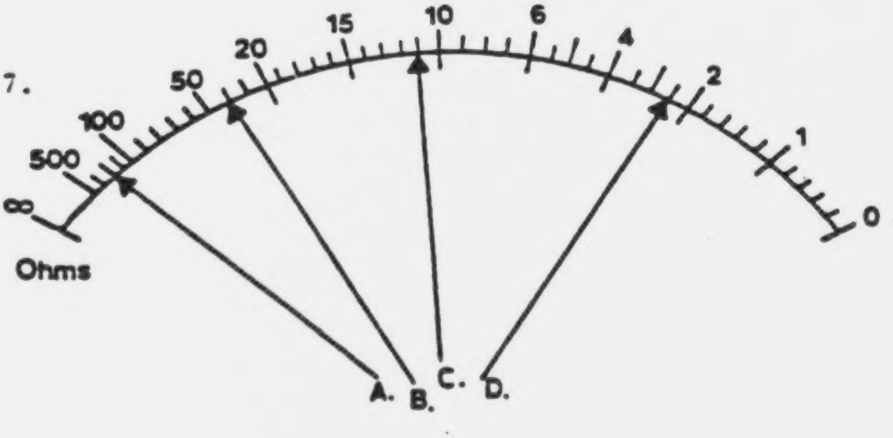
6A. ☐

6B. ☐

6C. ☐

6D. ☐

7.


∞
500
100
50
20
15
10
6
4
2
1
0
Ohms
A.
B.
C.
D.

7A. ☐

7B. ☐

7C. ☐

7D. ☐

SCORE:

GRADE:

Name: ____________________

Date: ____________________

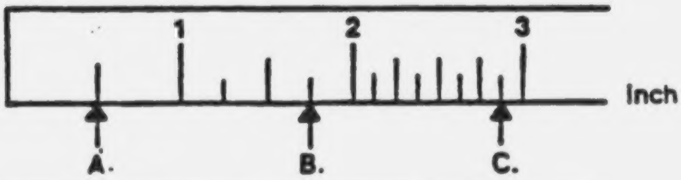
Period: ____________________

WORKSHEET

READING METER SCALES

Read and record the value indicated by the scale/pointer combinations below:

1.

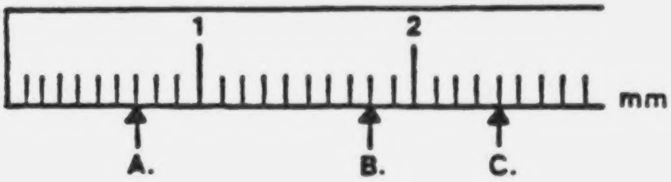

1
2
3
inch
A.
B.
C.

1A. ☐

1B. ☐

1C. ☐

2.

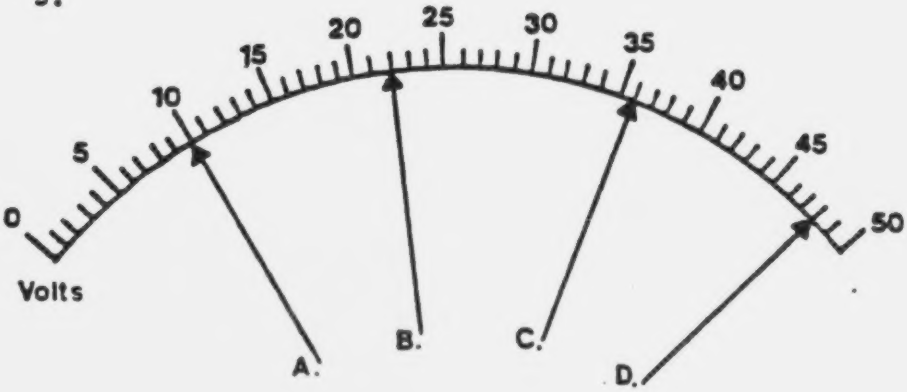


2A. ☐

2B. ☐

2C. ☐

3.


0
5
10
15
20
25
30
35
40
45
50
Volts
A.
B.
C.
D.

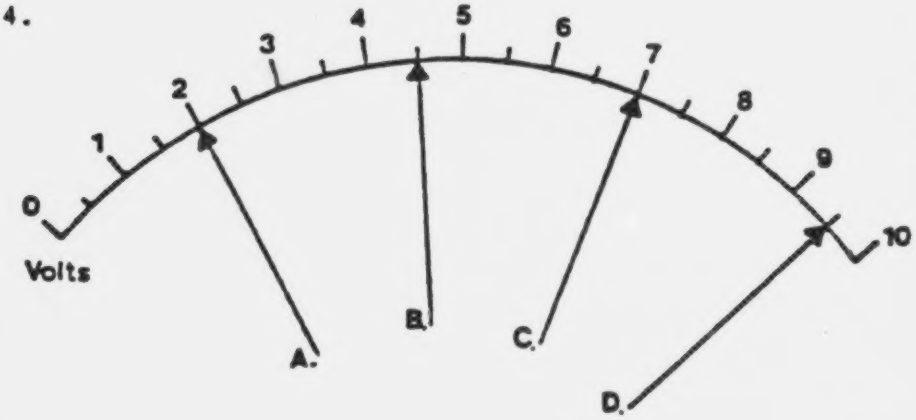
3A. ☐

3B. ☐

3C. ☐

3D. ☐

4.


0
1
2
3
4
5
6
7
8
9
10
Volts
A.
B.
C.
D.

4A. ☐

4B. ☐

4C. ☐

4D. ☐

Name: ____________________

Date: ____________________

Period: ____________________

21. When measuring an unknown value of voltage, the range switch should be set to its __________ position. 21.

22. What is the purpose of the zero adjust control on a meter?

23. Explain what is meant by the expression "observing polarity."

24. Draw a sketch which illustrates how a meter should be connected to measure voltage.

25. Draw a sketch showing how to connect a meter to measure resistance.

SCORE:

GRADE:

Name: __________

Date: __________

Period: __________

WORKSHEET

QUEST ACTIVITY

"UNIT 9"

MATCHING #1

1. Voltage
2. Resistance
3. Ampere
4. Current
5. Volt
6. Ohm

A. V
B. O
C. I
D. E
E. A
F. R
G. C
H. Ω

1. ☐
2. ☐
3. ☐
4. ☐
5. ☐
6. ☐

MATCHING #2

7. Ammeter
8. Voltmeter
9. Ohmmeter
10. Multimeter
11. Must be connected across the component.
12. All power must be off in circuit.
13. Selects mode of operation; what is to be measured.
14. Sets maximum value that can be measured.

A. Measures resistance in ohms.
B. Function switch
C. Measures voltage in volts
D. Voltmeter
E. Ohmeter
F. Measures current in amps.
G. Measures voltage in volts, current in amps and resistance in ohms.
H. Range switch

7. ☐
8. ☐
9. ☐
10. ☐
11. ☐
12. ☐
13. ☐
14. ☐

- -

15. The basic unit for measuring electrical current is the __________. 15. ☐
16. The force or pressure which causes electrons to move through a circuit is called __________. 16. ☐
17. __________ is the actual orderly flow of electrons through a circuit. 17. ☐
18. The basic unit of measurement for resistance is the __________. 18. ☐
19. __________ is a measurement of the opposition that a component or circuit offers to current flow. 19. ☐
20. Voltage is measured in the basic unit __________. 20. ☐

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

SHOP METER

In the space provided, make an accurate drawing of the shop meter. Label all controls and terminals.

Shop Meter

In the space provided, describe the purpose of the shop meter - why is it such an important piece of test equipment?

Test # ____________

UNIT EXAM

The Electrical Team

IMPORTANT:

Indicate your response on the answer sheet only. Fill in the box corresponding to the correct answer to each question. There is only one correct answer for each question.

1. The letter symbol for voltage is V. (T - F)

2. Voltage and electromotive force mean the same thing. (T - F)

3. The symbol , which apprears on some ohmmeter scales, means infinity. (T - F)

4. Zeroing a meter is necessary to achieve accurate measurements. (T - F)

5. Electron flow in a DC circuit is always from negative to positive. (T - F)

6. To measure a DC voltage drop, the meter is connected across a a resistor and ploarity must be observed. (T - F)

7. When taking a resistance measurement, the circuit being tested may be left on, or turned off. (T - F)

8. Both current and voltage move or flow through a circuit. (T - F)

9. The function switch on a meter is used to set the needle or pointer to zero. (T - F)

10. When measuring an unknown value of voltage, the meter range switch should be set in its highest position. (T - F)

GLOSSARY

ELECTRONICS

TECHNICAL VOCABULARY

THE ELECTRICAL TEAM

ammeter
deflection
digital multimeter
electromotive force
function swith
infinity
mechanical zero
needle
scale
graduations
increments
assigned value
parallax problems
set the range swith
mid-scale
zero the meter
zeroing procedure
mechanical zero
stabilization
stabilized
disconnect leads
usable portion
center scale
meter malfunctions
damaged test leads
cryptic messages

GLOSSARY

ELECTRONICS

RELATED GENERAL VOCABULARY

THE ELECTRICAL TEAM

in conjunction
property
pressure
critical
adjust
achieved
refer to
improper
decode

ELECTRICAL TEAM

TEAM : nhóm (chỉ E, I, R)
- current (I): cường độ
- voltge (E): điện thế
- Resitance (R): điện trở

instrument : máy đo, dụng cụ

AMMETER : một máy dùng để đo "cường độ" dòng điện.
Ký hiệu : —Ⓐ—

AMPERE : đơn vị căn bản của số đo cường độ.
Ký hiệu bằng chữ : A

CURRENT : sự chảy tuần tự của âm điện tử qua một mạch điện. Cường độ được đo bằng đơn vị căn bản là amperes hay amps. Tuy nhiên milliamperes và microamperes cũng dùng như các đơn vị để đo.
Ký hiệu bằng chữ của cường độ : I

DEFLECTION : sự di chuyển của kim máy đo khỏi vị trí zero. (còn gọi là độ sai lệch của máy đo)

DIGITAL : . chỉ số.
. giá trị được đo biểu hiện trên máy đo.

DIGITAL MULTIMETER: một loại máy đo hỗn hợp điện thế, cường độ, điện trở. Mã trị số được đo hiện rõ trên máy đo.
viết tắt : DMM

ELECTROMOTIVE FORCE: Áp lực hay lực gây ra để âm điện tử di chuyển qua một mạch điện cũng còn gọi sức điện động. Ký hiệu bằng chữ : E. viết tắt là: EMF (điện vị khác nhau). ELECTROMOTIVE FORCE # VOLTAGE.

FUNCTION SWITCH : một công tắc dùng để chọn lựa tính chất điện (điện thế, cường độ hoặc điện trở) để đo.

Infinitive : giá trị cực đại liên tục (còn gọi vô cực)
Ký hiệu : ± ∞ (∞ : đọc là vô cực).

MECHENICAL ZERO : sự điều hoà máy về zero. Sự điều hoà này cần thiết cho sự đo máy nhận được trị số chính xác.

METER : một máy đo các tính chất điện như điện thế, cường độ, điện trở..v...v. Ký hiệu máy đo –Ⓜ–
Ký hiệu bằng chữ : M.

MULTIMETER : một máy dùng đo nhiều số lượng và tính chất điện như AC và DC của điện thế, cường độ và điện trở.

NEEDLE : Kim của máy đo còn gọi là POINTER.

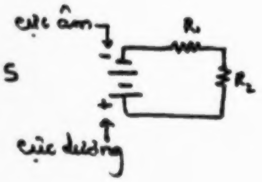
OHM : đơn vị căn bản dùng để đo điện trở. Ký hiệu là Ω (mê-ga) đọc là "OM".

OHMMETER : máy đo điện trở (như Sampson 260). Ký hiệu –(Ω)–

property : sự riêng biệt.
determining : sự xác định.
quality : tính chất
opposite charges : điện tích đối nghịch
positive : điện dương (+)
Negative : điện âm (-)

magnetic poles : cực nam châm.
NORTH : cực Bắc (N)
SOUTH : cực Nam (S)

(nam châm)



RANGE SWITCH : một nút điều chỉnh số lượng cao thấp của tính chất điện được đo. (còn gọi là nút chọn lựa trị số tối đa hoặc tối thiểu, thông thường trên OHMMETER giá trị kim chỉ trên cần phải nhân với (Range switch) chỉ số được ghi tại mũi tên chỉ của nút chọn lựa ta sẽ có trị số OHM của 1 điện trở được đo).

RESISTANCE : Điện trở hay cản điện. Đơn vị căn bản của điện trở là OHM (Ω). Kiloohm, Megaohm cũng là đơn vị để tính của điện trở (bội số). Ký hiệu của điện trở là : R

SCALE : đường hoặc cung trên mặt máy đo với sự chia bậc được ghi rõ giá trị chỉ số đo.

DECODE , Từ hình ảnh hoặc mã số phải dịch ra chữ thường bằng văn tự.

CRyptic message: dữ kiện khó hiểu, tin tức bí mật, văn tự mật mã hình ảnh khó hiểu.

accurate : chính xác
drawing :
draw (v) : vẽ
Label : ghi dấu hiệu
controls , các nút điều chỉnh

Terminals : các đầu dây để khảo sát hoặc phần tận cùng của một đường dây.
shop meter : máy đo trong lớp học

-3- ET.

Record	thu lại (ghi nghiệm số)
combination	sự kết hợp.
component	các thành phần điện như Resistor, capacitor, diode.
be off	tắt (tắt máy)
mode	cách thức, phương pháp (ở đây có nghĩa chọn Range Switch)
maximum	tối đa
minimun	tối thiểu
unknown value	giá trị chưa biết.
expression	sự phát biểu
observing polaRity	quan sát cực điện (thường thì âm nối với âm, dương nối với dương).
il'ustrate	vẽ tổng hình ảnh, tranh ảnh.
sequence	sự liên kết
utilize	dùng, hữu dụng
reference	sự tham khảo
guide	hướng dẫn.
Refer	tham chiếu, coi lại
Determine	xác định
match	xứng bộ
set	đặt
rest	nghỉ
avoid	tránh
parallax	sự đọc sai lầm trên cân của máy đo.
Identify	nhận rõ
be sure	chắc chắc
Select	chọn lựa.
peg	dấm kên (làm hư máy)
HINT	ám chỉ (mớm cho biết trước)
Critical	bình phẩm
mid-scale	miền cân (ở khoảng giữa của cân máy đo giúp cho sự đọc trị số khá chính xác)
stabilization	sự thăng bằng.
test leads	lai dẫn lấy đồ khảo sát.
achieve	đoạt được
troubleshooting	mầm phiền toái
Recheck	soát lại.

電器團隊 (ELECTRIC TEAM)
技術語彙

安培計(AMMETER)：設計測量电流流动量的儀錶.
符号：—Ⓐ—

安培(AMPERE)：測量电流流动量的基本單元。文字符號：A

电流(CURRENT)：电子有規律地通过电路謂之电流。其基本計量單元是安培(amperes or amps)，但千分之一安培(milliamperes)或百萬分之一安培(microamperes)也被用到。
文字代號為：I.

偏向(度)(DEFLECTION)：电錶指針由零位置偏斜之动作。

數字式多功能电錶(DIGITAL MULTIMETER)：一种多功能的电錶其输入或測得之值是从发亮的數目字顯示出來。
缩写為：DMM.

电子移动力(ELECTROMOTIVE FORCE)：引起电子通过电路流动的压力(推力)也称作伏特(voltage)电压.
文字代號：E 缩写為：EMF

操作功能鍵(FUNCTION SWITCH)：用在选擇欲測的电器性質(electrical quantity)如电压(voltage)，电流(current)或电阻(resistance)的选擇鍵鈕。

无限大(INFINITY)：一个十分大的數值其无法用數目表達的連續性无限制地大。符號：∞.

机械的零点(MECHANICAL ZERO)=利用机械性地组合配件而能調整儀錶指針移位至零点．此项調整对精確测量是必要的。

电錶(儀錶)=测定电性質量的儀錶如测电压,电流,电阻等之多少. 符号: —Ⓜ— 文字符號=M

多功能电錶(MULTIMETER)=电錶可以测一种以上的电器性質量.大多數多功能电錶可测交流(AC)及直流(DC)电压,交流及直流电流,电阻.

指針(NEEDLE, POINTER):在电錶上指示數值的配件.指針及錶面刻度相配合出测得之值.

歐姆(OHM)=計量电阻值的基本单元.文字符號=Ω

歐姆計(OHMMETER):测量电阻值的儀錶.符號:—Ω—

極性(POLARITY)=电流或某装備的一种性能以决定电流的流向.其具有兩种性質,一為"正"(+)另為"負"(-).在磁场上也有兩相对的極性,一在"北"另一在"南".

範圍鍵(RANGE SWITCH):选擇电錶可测之最大數值的鍵鈕 許多範圍是呈倍數级式,

电阻(RESISTANCE):組件或电路对电流流动所提供的抗阻大小之量.其基本单元為歐姆(ohm),但千歐姆(kilohm)及百萬歐姆(megohm)也常用到. 文字符号:R

刻度(SCALE)=在儀器(instrument)或儀錶(meter)面上呈直线或弧形而分隔成許多相等間隔或呈不等相间隔的錶面以指示數值.

讀电錶的程序

PROCEDURES IN READING A METER

1. 檢查操作鍵鈕.
   決定何种电器性能量要測

2. 找出刻度
   找出配对範圍鍵所選擇的範圍的刻度线.

3. 讀刻度.
   当指針擺动停止後,臉正对刻度面讀出數值.

4. 查閱範圍鍵
   確認範圍級數以便決定乘多少倍數

5. 乘刻度讀數.
   用刻度讀得之數值乘以範圍鍵指的倍數

6. 則你得到所測之數值.
   当你記錄你所讀得之值時,一定也要把你測的电性能的基本單元記上～即伏特(volts),歐姆(ohms)或安培(amp:

HOW TO USE A METER TO MEASURE VOLTAGE OR RESISTAN

measure = 测量.

set = 訂位, 选訂.

electrical quantity = 电器性能质量.

Identify = 檢定, 確定.

caution = 小心, 注意.

high enough position = 足夠大的位置

HINT = 暗示, 示意.

highest position = 最大位置

unknown value = 不知數

critical = 精確的.

zero the meter = 歸零, (电錶歸零調整).

insure = 確保

accurate = 正確的.

stabilization = 穩定 (性)

test leads = 测量引线.

indicator = 指示器 (即指針)

Disconnect = 分離、分開.

infinity = 无限大.

repeated = 重複做

achieve = 得到

parallel = 平行, 並聯.

positive : 正, "+" (红色引线)

negative : 負, "−" (黑色引线)

usable portion = 可讀出(可用到的)的部位.

series = 串聯.

observed = 觀测, 注意.

close = 接近

vary : 变換, 轉变.

malfunctions : 故障、机能不全.

recheck : 再次檢查 = Double check

touch : 以手去接觸.

英文請閱原文第5,6,7頁.　　p.5,6,7.

ELECTRONIC CURRICULUM

VOCATIONAL TRAINING [illegible]N PLAN # II OHMS Law

Teaching Materials Source ______________________________

Chapter ____________, pages ____________

Lab Manual pages ____________

Additional Instructor Materials ______________________________

Main concepts student will learn:

1. To learn the mathematical relationships of voltage, current, and resistance.
2. To demonstrate these relationships in several electrical circuits.
3. To determine experimentally the mathematical relationship between current, voltage and resistance.

Technical Vocabulary

Related General Vocabulary

Teaching Activity

1. Review the key terms of voltage resistance and current, Be sure the symbols for the units of measurement, and a clear working definition are understood.

   Go through exercise 1 with the class and use this to help the class learn Ohms Law, and work out the solutions by reasoning rather than on the calculator.

   Take time to develop the concepts of a direct proportion and an indirect proportion.

Materials and Notes

Length of Lesson

1 week

Evaluation

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of oral or written testing procedures.

OHM'S LAW

INFORMATION SUMMARY

Ohm's Law is a fundamental relationship between current, voltage, and resistance.

It states that the current in any circuit is directly proportional to the applied voltage.

As voltage increases--current increases.
As voltage decreases--current decreases.

It also states that the current in the circuit is inversely proportional to the resistance.

As resistance increases--current decreases.
As resistance decreases--current increases.

The mathematical expression of Ohm's Law is:

$$I = \frac{E}{R}$$

where: I = Circuit current in amperes
E = Applied voltage in volts
R = Circuit resistance in ohms

Ohm's Law equation may be converted to two other forms. By multiplying both sides by R, the following is obtained,

$$E = IR$$

and by multiplying both sides of the first equation by:

$$\frac{R}{I}$$

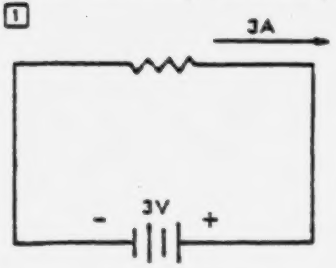
we have:

$$R = \frac{E}{I}$$

EXERCISE 1

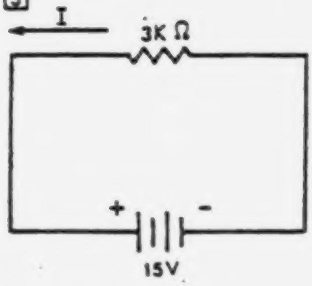
Memorize the Ohm's Law equations by working the following problems. Do mentally without writing the equations. Check by writing the equation and solving.

1



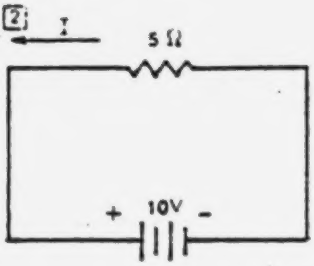
R = ______

5



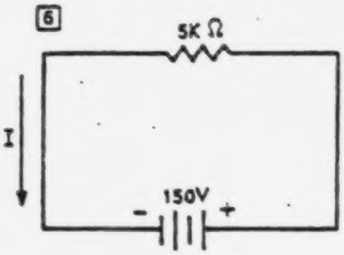
I = ______

2



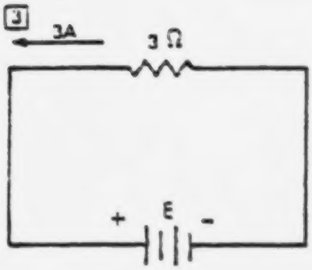
I = ______

6



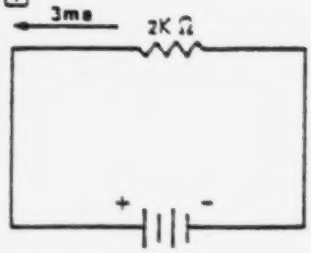
I = ______

3



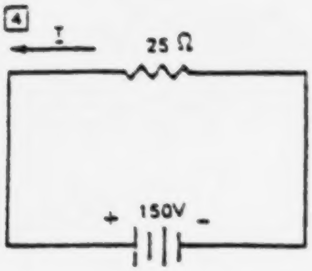
E = ______

7



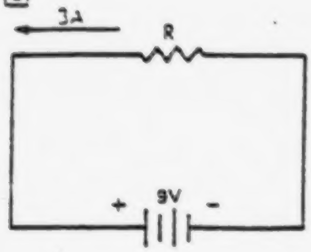
E = ______

4



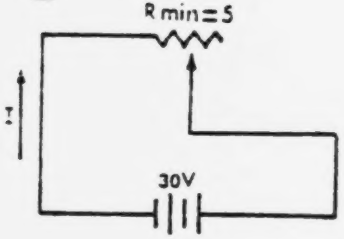
I = ______

8



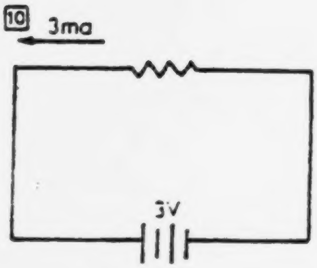
R = ______

9



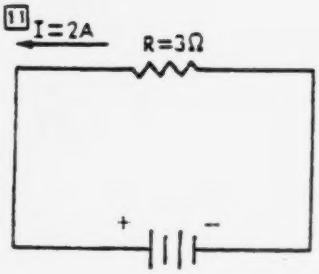
I_{max} = ______

10



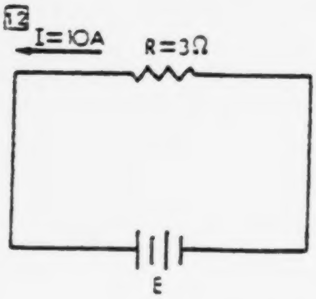
R = ______

11



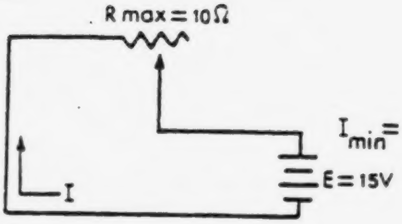
E = ______

12



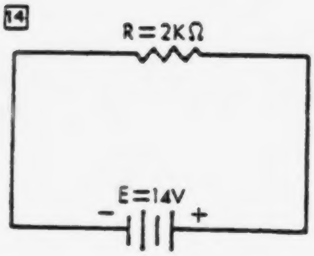
E = ______

13


R max = 10Ω
I
E = 15V

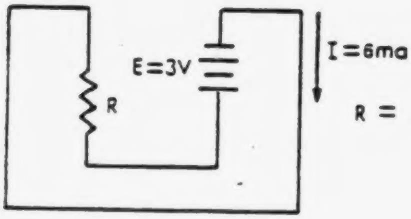
I_{min} = ______

14



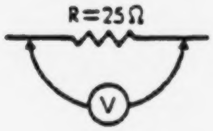
I = ______

15



R = ______

16. How much current is flowing through the following resistor if the voltmeter reads 25 volts?



I = _____

17. If the voltmeter reads 50v? I= ________

18. If the voltmeter reads 12.5v? I= ________

19. What happenes to the current in a circuit if the voltage is doubled? Current ________________.

20. If the voltage is cut in half? Current ________________.

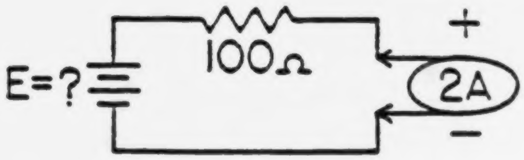
21. Design a simple circuit which will function on a 15 volt battery and have a circuit current of 3 ma. Draw the schematic and indicate values.

Name: ____________

Date: ____________

Period: ____________

11. Solve for voltage "E" in the circuit below:



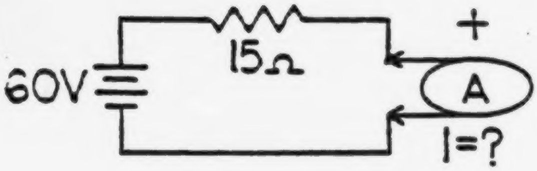
Formula: E = I x R

Enter values: E = ____x____

Solution: E = ______ ____

unit

12. Solve for current "I" in the circuit below:



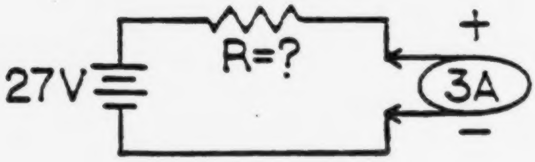
Formula: I =

Enter values: I =

Solution: I = ______ ____

unit

13. Solve for resistance "R" in the circuit below:



Formula: R =

Enter values: R =

Solution: R = ______ ____

unit

OHMS LAW CLASS NOTES

I. Formula E=IR

R=10 Ω	R=10 Ω	R=10 Ω
I=2a	I= 3a	I= 4a
E=____	E=____	E=____

Summary of Results ____

____

____

Conclusion ____

____

____

II. Formula E=IR

I=2a	I=2a	2a
R=10 Ω	R=20 Ω	R=30 Ω
E=____	E=____	E=____

Summary of results ____

____

____

Conclusion ____

____

____

III. Formula $I={}^{E}/R$

E=10V	E=10V	E=10V
R= 2 Ω	R= 4 Ω	R= 6 Ω
I-____	I-____	I=____

Summary of results ____

____

____

Conclusion ____

____

____

IV. Formula $R={}^{E}/_{I}$

E=20V	E=20V	E=20V
I= 2a	I= 4a	I= 5a
R=____	R=____	R=____

Summary of results ______________________________

____

____

Conclusion ______________________________

____

____

POWER OF 10's REVIEW FOR OHMS LAW

I. When you multiply using power of 10's you ________ the numbers and ____________ the exponents.

Examples:

Positive Exponents		Power of 10's		Eng. Not.
$(5X10^3)\ (3X10^3)$	=	____________	=	_________
Negative Exponents				
$(5X10^{-2})\ (3X10^{-3})$		____________	=	_________
Neg/Pos. Exponents				
$(5X10^2)\ (3X10^{-3})$		____________	=	_________

II. When you divide using power of 10's you ______________ the numbers, ____________________ of the exponent on the bottom and ____________________ the exponent on the top.

Examples:

Positive Exponents		Power of 10'a		Eng. Not.
$\frac{6X10^3}{3X10^3}$	=	____________	+	_________
Negative Exponents				
$\frac{6X10^{-3}}{3X10^{-4}}$	=	____________	=	_________
Pos./Neg. Exponents				
$\frac{6X10^{-3}}{2X10^{4}}$	=	____________	=	_________

III. Converting scientific notation to Eng. Notation.
Rules to follow:

If the unit of measurement is getting __________, then the number of units you have gets _____________.

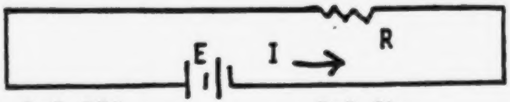
If the unit of measurement is getting _____________, then the number of units you have gets _________________.
.005 a = __________ ma or IK Ω = _______________________.

ROP ELECTRONIC TECHNICIAN

NAME________________________

OHM'S LAW

Find the unknown value for the following problems. Put the answers in the blanks on the right.



1.	E=________	I=0.05A	R=2.2k	?________
2.	E=12V	I=________	R=1K	?________
3.	E=8V	I=0.05A	R=________	?________
4.	E=________	I=0.25A	R=3.3K	?________
5.	E=5V	I=________	R=1 OHM	?________
6.	E=10V	I=2A	R=________	?________
7.	E=________	I=8A	R=470	?________
8.	E=50V	I=________	R=100	?________
9.	E=250V	I=10A	R=________	?________
10.	E=________	I=3mA	R=100	?________
11.	E=250V	I=________	R=5M	?________
12.	E=15V	I=3mA	R=________	?________
13.	E=________	I=2mA	R=1.8K	?________
14.	E=15V	I=________	R=10	?________
15.	E=20KV	I=5A	R=________	?________
16.	E=________	I=5mA	R=100M	?________
17.	E=30V	I=________	R=15K	?________
18.	E=5V	I=2uA	R=________	?________
19.	E=________	I=25uA	R=50	?________
20.	E=5.5V	I=________	R=10K	?________
21.	E=50V	I=500uA	R=________	?________

OHMS LAW PRACTICE #2

Name ____________________ **Date** ____________

Find the unknown and put the answer on the blank.

18.8 V 69 mA ________

1.18 MΩ 14.2 mA ________

1.29 mA 3.7 KΩ ________

1.07 mA 86 V ________

117 V .955 mA ________

1.44 MΩ 1.25 mA ________

100 V 6.4 A ________

7.46 mA 183 MΩ ________

1.02 KΩ 2 V ________

9.5 Ω 1.34 mA ________

11.6 A 17.8 V ________

21.3 uA 1.94 MΩ ________

19 V 1.14 MΩ ________

164 Ω 0.92 KV ________

16.2 mA 0.89 KΩ ________

0.54 mA 50 V ________

84 uA 194 uΩ ________

1.16 mA 60 KΩ ________

60 V 1.18 mA ________

1.73 KΩ 11.1 V ________

139 Ω 11.9 uA ________

71 Ω .1 A ________

.65 mA 165 KΩ ________

126 V .142 Ω ________

1.90 mV 100 Ω ________

7.1 A 17.5 V ________

7.7 mV 1.33 KΩ ________

9.7 Ω 1.24 V ________

139 V 100 uA ________

.004 A 14 V ________

1.91 KΩ 0.67 mA ________

1.57 MΩ 13.1 V ________

76 V 137 KΩ ________

14 Ω 66 mA ________

OHMS LAW PRACTICE #3

NAME______________________________ DATE_______________

Find the unknown and put the answer on the blanks.

87V	53mA	____________	1.83mA	90K Ω	____________
4.7M Ω	31mA	____________	171V	1.23mA	____________
1.84mA	13.8K Ω	____________	3.02K Ω	16.1V	____________
1.96mA	16.4V	____________	136 Ω	87uA	____________
72V	1.31mA	____________	17 Ω	9A	____________
1.96M Ω	7.9mA	____________	15mA	115K Ω	____________
32V	144A	____________	128V	189 Ω	____________
1.56mA	111M Ω	____________	2.90mV	24 Ω	____________
1.57K Ω	60V	____________	2.4A	4.6V	____________
4.6 Ω	1.1mA	____________	12.3mV	1.22K Ω	____________
17.7A	7.7V	____________	8.6 Ω	1.35V	____________
3.93uA	1.17M Ω	____________	52V	183uA	____________
84V	1.19M Ω	____________	12.7A	133V	____________
104 Ω	1.88KV	____________	4.6K Ω	0.57mA	____________
11.8mA	0.87K Ω	____________	1.43M Ω	16.8V	____________
4.58mA	81V	____________	117V	132K Ω	____________
68uA	157u Ω	____________	11.5 Ω	0.13mA	____________

OHMS LAW PRACTICE #4

NAME______________________________ DATE________________

Find the unknown and put the answer on the blanks.

53V	99mA	____________	1.32mA	94K Ω	____________
1.3M Ω	94mA	____________	144V	51mA	____________
1.6mA	15.3K Ω	____________	1.01K Ω	3V	____________
32mA	46V	____________	113 Ω	81uA	____________
110V	1.31mA	____________	179 Ω	50A	____________
1.58M Ω	1.36mA	____________	97mA	34K Ω	____________
68V	71A	____________	115V	72 Ω	____________
9.1mA	86M Ω	____________	1.10mV	77 Ω	____________
1.7K Ω	26V	____________	4.2A	180V	____________
63 Ω	65mA	____________	4.5mV	1.48K Ω	____________
14.7A	185V	____________	153 Ω	6V	____________
1.73uA	0.60M Ω	____________	60V	173uA	____________
98V	6.8M Ω	____________	64A	101V	____________
13 Ω	0.80KV	____________	1.6K Ω	0.44mA	____________
52mA	1.02K Ω	____________	0.51M Ω	83V	____________
1.38mA	50V	____________	162V	29 Ω	____________
12uA	24u Ω	____________	3 Ω	187mA	____________

OHME LAW PRACTICE #5

NAME: ________________________________ DATE: ________________

Instructions: Find the unknown and put the answer on the blanks

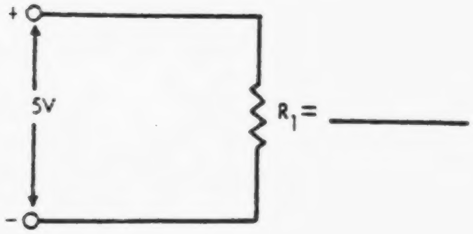
34 V	166 mA	________	1.32 mA	133 K Ω	________
56 MΩ	80 mA	________	124 V	138 A	________
9.9 mA	17.3 K Ω	________	1.09 KΩ	70 V	________
190 mA	92 V	________	90 Ω	179 μA	________
48 V	1.84 mA	________	75 Ω	6 A	________
1.26 m Ω	36 A	________	47 mA	172 KΩ	________
12 V	17 A	________	85 V	131 Ω	________
1.44 mA	1.81 M Ω	________	1.54 mV	92 Ω	________
1.97 K Ω	60 V	________	1.06 A	116 V	________
9 Ω	148 mA	________	1.11 mV	1.12 K Ω	________
65 A	151 V	________	174 Ω	7 V	________
1.67μA	1.02 M Ω	________	37 V	129 uA	________
153 V	8.4 MΩ	________	19 A	182 V	________
10 Ω	1.92 KV	________	20 KΩ	1.43 mA	________
161 mA	1.72 K Ω	________	1.22 M Ω	1.58 V	________
1.05 mA	86 V	________	75 V	75 Ω	________
37 μA	28 MΩ	________	53 Ω	99 mA	________

EXPERIMENT

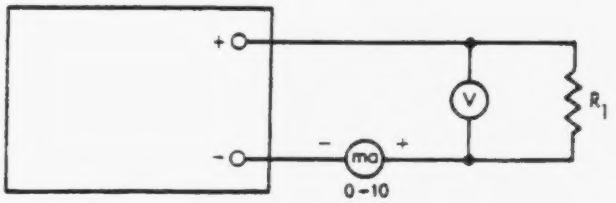
EXPERIMENT 1

EQUIPMENT:
1. Voltmeter-Ammeter-Ohmmeter
2. Power supply-low voltage DC
3. Resistor

PROCEDURE:
1. Using Ohm's Law, compute the resistance value of R_1, which will allow 5 ma of current to flow in the circuit, when 5 volts is applied.



2. Verify circuit operation:
   - (a) Select resistor of computed value and measure its resistance with an ohmmeter. It should be 1K ± 10% (990-1,100Ω).
   - (b) Connect one end of the resistor to the + terminal of a low voltage power supply. CAUTION: The power switch should be "OFF."
   - (c) Connect the other end of the resistor to the + terminal of a 0-10 ma milliammeter.
   - (d) Connect the - terminal of the milliammeter to the - terminal of the power supply.
   - (e) The circuit should now be connected as follows:



(f) Turn the voltage control knob of the power supply to minimum. Turn the power switch to "ON", and slowly adjust the voltage applied to the resistor until it is 5V.

(g) Read and record the measured value of current from the milliameter ________________.

(h) Does the computed value agree with the measured value?

____________________.

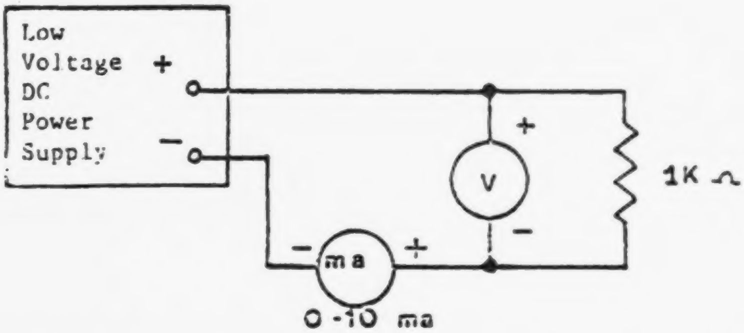
If not, why? ______________________________________

____.

EXPERIMENT 2

MATERIAL:
1. Low voltage power supply
2. 1000 ohm resistor
3. 0-10 ma. meter
4. VTVM

PROCEDURE:
1. Following the procedure outlined in Experiment #1, connect the circuit as shown below: Caution: Power should be "OFF" and observe polarities of the power supply and milliammeter.



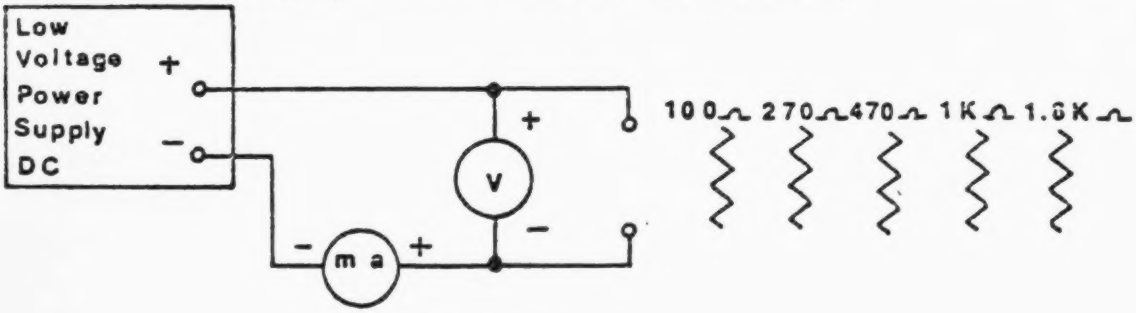
2. Apply voltage across the 1 k as listed in below chart and record current flow for value of voltage.

E	R	I
2	1 K	
4	1 K	
6	1 K	
8	1 K	
10	1 K	

EXPERIMENT 3

MATERIAL:
1. DC low voltage power supply
2. 0-10, 0-100 ma meters
3. 100, 270, 470, 1 k, and 1.8 k resistors
4. VTVM

PROCEDURE:
1. Following the procedure outlined in Experiment #1, connect the circuit as shown below. One at a time each resistor is to be connected in the circuit in series with the 0-100 milliammeter. Caution: Power "OFF", when changing resistors observe correct polarity.

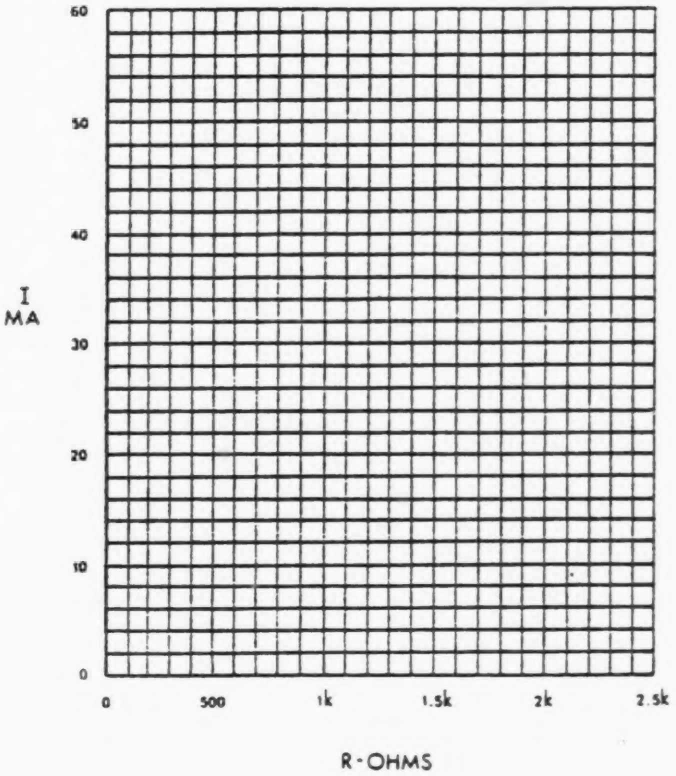


0-100 (or 0-10)

2. Apply power, adjust for 5V. with each resistor in the circuit and record current values for each resistor. (use one resistor at a time, and check voltage across each). If current value is below 10 ma, substitute the 0-10 mA meter for the 0-100 mA meter.

RΩ	E	I
100	5	
270	5	
470	5	
1K	5	
1.8 K	5	

3. Plot I R curve on graph from information developed in table.



Self Test

Directions

Do the following problems. 90% accuracy is considered passing for this test.

1-2. R is the symbol for ______________, which is measured in ___________.

3-4. The symbol for current is ___________ and measured in _______________.

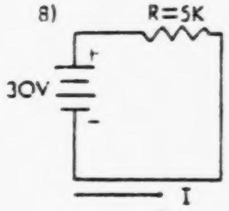
5. What is the relationship between current and voltage in a circuit?

6. Write the mathematical expression of Ohm's Law used for determining the applied voltage in a circuit.

7. Write the mathematical expression of Ohm's Law used for determining the resistance in a circuit.

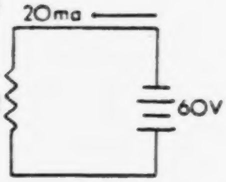
8-12 Find the indicated values in the following circuits.

8)



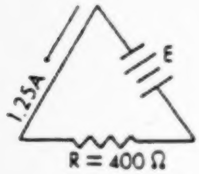
I = ______

9)



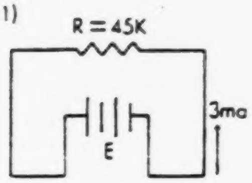
R = ______

10)


1.25A
E
R = 400 Ω

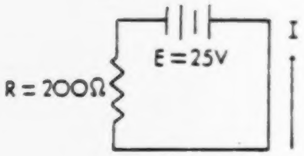
E = ______

11)



E = ______

12)


I
E = 25V
R = 200Ω

I = ______

13. Design and draw the schematic of a simple circuit which will function on 16.5V and have a circuit current of 35 ma.

14. Construct the circuit you designed in question 13. Measure the current to verify that it is 35 ma ± 10%.

CONFIRMATION OF OHM'S LAW

Lab Sheet #6

OBJECTIVES

To learn to measure current with a milliammeter
To learn Ohm's Law relationships between current, voltage, and resistance
To learn what factors affect power in a circuit

MATERIAL

VTVM OR VOM
DMM
Solderless Breadboard
Resistors: 1k, 2k, 4.7k, 10k, 15k
Potentiometer: 10k

INTRODUCTION

George S. Ohm was an early experimenter in electrical phenomena. He discovered that the CURRENT flow in a circuit was a function of the VOLTAGE and RESISTANCE. This relationship is expressed by this formula:

$$I = \frac{E}{R}$$

Where: I = CURRENT, E = VOLTAGE, and R = RESISTANCE.

In these Projects you will connect a power supply to a resistor and make measurements of voltage and current. You should find that these three factors always relate in accordance with Ohm's Law. You will be holding one factor constant and varying another to see how the third factor is affected. These relationships are the most important concepts in electronics. Devote as much time and energy as necessary to completely understand these concepts. Do not go to the next Lab Sheet until you understand Ohm's Law.

PROJECT 1: Observing How Resistance Affects Current in a Circuit

INSTRUCTIONS

1. Locate the resistors listed in TABLE 1 and measure the exact resistance of each. Record in TABLE 1 under the "DMM Measured Resistance" column. Do not complete any other column until directed to do so.

TABLE 1

Resistance Value (ohms)	DMM Measured Resistance (ohms)	VTVM Measured Volts (V)	DMM Measured Current (mA)	Calculated Current (mA)	Calculated Power (mW)
1k					
2k					
4.7k					
10k					

2. Carefully follow the schematic and drawing to connect the 1k resistor to the power supply and DMM ammeter. Do not turn the power supply "on" until directed.

HINTS:

R1 in this and future schematics is not the resistor you listed in your Parts Kit inventory as R1. In this schematic, R1 is the designation of the only resistor used in the circuit. If another resistor is added to the circuit, it will be R2 -- no matter what value it is.

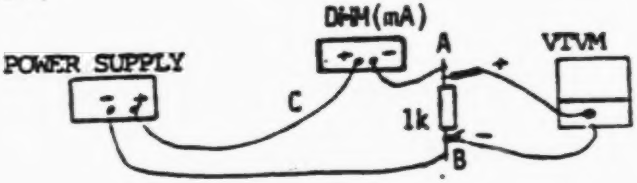
Use the solderless breadboard to hold the resistor.

Use banana plug leads at the power supply and the DMM.

Either end of the resistor can be made point "A" or "B".

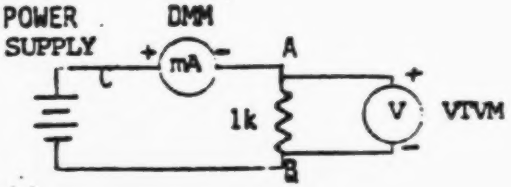
When using the DMM to measure current, use the black COMMON jack for "-" and the red "mA" jack for "+" as shown below.

Figure 1A



Below is the schematic representation of the above circuit.

Figure 1B



VTVM settings:

Range selector: 15v

Function: +DC Volts

3. Check the wiring of your circuit. Start now to use these procedures every time you connect a circuit. (NOTE: Failure to do this is a major reason that many students do poorly in this electronics program.)

a. Look at the schematic and note what is supposed to be connected to the power supply "+" jack. (Only one wire going to the DMM "+ mA" jack.)

b. Physically trace the wire from the power supply "+" jack to the DMM. There should be no other connections along the wire. The wire should go only to one place: the DMM red jack marked "mA".

c. Focus your full attention on the next part of the circuit: from the DMM COMMON(black) jack to the resistor. The resistor has two things connected to the "A" end: the wire from the DMM COMMON(black) jack and the VTVM probe. Do you have only these two things connected -- nothing less or nothing more? YES/NO

d. Continue checking the "B" end of the resistor the same way. Do you have only two leads connected? Is one of them the COMMON from the VTVM and is the other one the banana lead from the power supply "-"?

4. Check the statement below which pertains to you:

____ I have carefully checked the circuit point by point exactly as outlined in "a" through "d" above. I know every connection is exactly as specified on the schematic. I am aware that one small mistake on the job could be disastrous to equipment and my future with my employer. I am starting now to practice checking carefully everything I do. I want to do a good job and have a satisfying and rewarding career in electronics.

____ I didn't check everything because I'm in a hurry to get through this program, get a job, make lots of money, and have some fun. I don't need to check everything. I'm sure I'm almost always right. Besides, I have good luck so I don't worry myself with little things. Maybe I'll get a good boss who won't be "picky". If my luck does change, I'll find plenty of excuses that will probably get me out of any trouble. I've always done good in the past and will probably be able to stay with each employer a year or two -- with a little luck.

____ I checked the circuit until I got bored. If there is something wrong, I'm sure it will show up and then I can correct it. That has worked so far at home. Probably will work on the job, if I decide to get one someday.

____ I didn't bother checking because I'm not being graded on this. I would check better if it counted on my score. I've got a 3.8765 average score so far and that is all I worry about. If I keep my score up, I'll be able to impress some employer and get a high paying job. I'm proud of my high scores and it really shows how smart I am. I've got a good lab partner from whom I copy so that I can maybe even raise my score. With my high scores I'll be offered lots of good paying jobs, make lots of money, and be happy forever. My parents always said I was really smart. I'm probably a genius.

5. Have you gotten the point about carefully checking the circuit? If so, prepare to apply power to the circuit by using the procedure on the next page:

a. Turn the power supply voltage controls fully counterclockwise.

b. Turn the power supply "on".

c. Adjust the power supply voltage to exactly 5 volts across the resistor, as measured by the VTVM. NOTE: The VTVM is more accurate than the power supply voltmeter and is connected directly across the resistor where we want 5 volts.

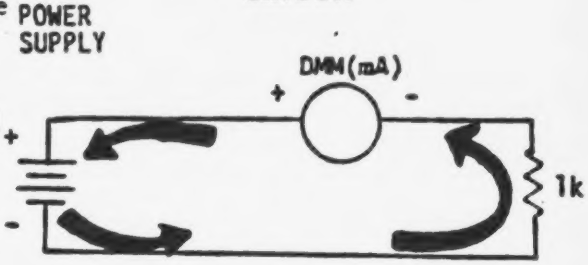
6. Record the exact voltage measured on the VTVM in TABLE 1 under "VTVM Measured Voltage".

7. Measure the current flow through R1 by reading the DMM milliammeter. Record the current flow in TABLE 1 under "DMM Measured Current".

8. Turn the power supply "off" and let's study exactly what is happening:

Notice that the circuit is completed with no opens in it. Electrons are leaving the negative terminal of the power supply and are returning to the positive terminal of the power supply. The electrons pass through the resistor and through the DMM milliammeter. The DMM milliammeter measures how many electrons are flowing and reads this out in milliamperes. At the same time the VTVM voltmeter is measuring the voltage across the resistor. Voltage is the "pressure" in the circuit. The voltage is what keeps the electrons moving.

CURRENT FLOW IN THE CIRCUIT



The resistor is the only thing limiting the electron flow. Without the resistor there, the current would be extremely high and the DMM possibly could be damaged.

9. Remove the 1kohm resistor and replace it with a 2kohm resistor.

10. Turn the power supply "on" and make sure there are exactly 5 volts across R1. Record the voltage in TABLE 1.

11. Measure and record the current flowing through the 2kohm resistor.

12. Replace the 2kohm resistor with a 4.7kohm resistor. Measure and record the voltage and current as done in STEPS 10 and 11.

13. Replace the 4.7kohm resistor with a 10kohm resistor. Measure and record the voltage and current as done in STEPS 10 an 11.

14. Turn the power supply "off". Using Ohm's Law, calculate the value of current for each resistor. Record in TABLE 1 under Calculated Current.

$$I = \frac{E \quad \text{(the exact voltage across the resistor)}}{R \quad \text{(the exact resistance of the resistor)}}$$

Example: To calculate how much current should flow through a 1kohm resistor with 5 volts applied across it do this:

$$\frac{5.0 \text{ volts}}{1000 \text{ ohms}} = .005 \text{ or } 5 \text{ mA.}$$

15. Compare your calculated current values with the measured values. Are they within 10%? YES/NO

16. Just for practice, calculate the power in each resistor. Record in TABLE 1 under Calculated Power. NOTE: We cannot measure power directly, so we must always calculate it from our other measurements. Power can be calculated three different ways:

$$P = \frac{E^2}{R} \qquad \text{or} \qquad P = E \times I \qquad \text{or} \qquad P = I^2 \times R$$

SUMMARY

You should have observed that, for a given voltage, the amount of current flowing was dependent on the resistance. This can be expressed by Ohm's Law like this:

As R goes up, I goes down: $\downarrow I = \dfrac{E \text{ (held constant)}}{R\uparrow}$

And

As R goes down, I goes up: $\uparrow I = \dfrac{E \text{ (held constant)}}{R\downarrow}$

Further, you should have observed that as the current increased (with voltage held constant) the power increased. This is in accordance with Watt's Law:

$I \times E = P$ Where I is in amperes, E is in volts, and P is in watts.

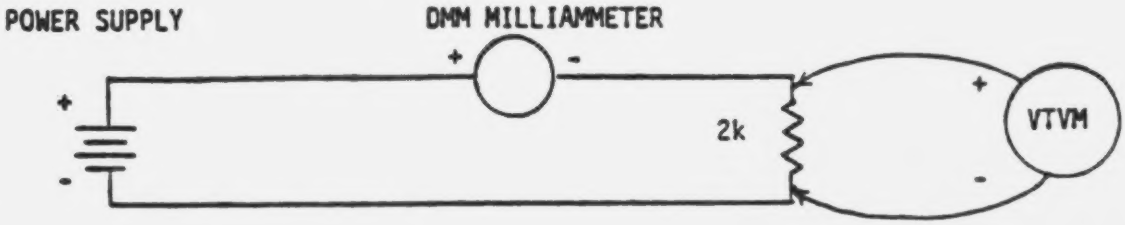
PROJECT 2: Observing How Voltage Affects Current Flow

INTRODUCTION

In this Project you will use only the 2kohm resistor. Resistance will be held constant and voltage will be changed. You should see that current will be affected in accordance with Ohm's Law.

INSTRUCTIONS

1. Connect the circuit shown below with the power supply set to 0 volts.



2. Using Ohm's Law, calculate the voltage required to cause 1 milliampere(mA) to flow through the 2kohm resistor. Record in TABLE 2 under "Calculated Voltage".

3. Do the same thing for each of the other values of current in TABLE 2 and complete the "Calculated Voltage" column.

4. Turn the power supply "on". Raise the voltage slowly while watching the DMM milliammeter. Adjust the voltage until you read 1 mA on the DMM. Then read the voltage on the VTVM. Record this voltage in TABLE 2 under the "VTVM Measured Voltage" column.

5. Repeat STEP4 procedures for each different current value in TABLE 2.

TABLE 2

Resistance (ohms)	DMM Measured Current (mA)	Calculated Voltage (V)	VTVM Measured Voltage (V)	Calculated Power (P)
2k	1.0 mA			
2k	2.0 mA			
2k	4.0 mA			
2k	8.0 mA			

6. Compare the Calculated Voltage and the VTVM Measured Voltage in TABLE 2. Are they within 10% of each other? YES/NO

7. Just for practice, calculate the power in the resistor for each different voltage. Use the measured values and record in the last column of TABLE 2.

SUMMARY

You should have observed that with a fixed value of resistance, more voltage was required to pass more current. This is in accordance with Ohm's Law:

$$\frac{\uparrow E}{R} = I\uparrow \quad \text{and} \quad \frac{\downarrow E}{R} = I\downarrow$$

PROJECT 3: Practice Working with Ohm's Law

INTRODUCTIONS

The following Projects will give you practice in working with Ohm's Law while wiring circuits and making measurements. You will be using a potentiometer for the required value resistance. Be sure not to decrease the potentiometer resistance while it is in the circuit. Do not attempt to measure the resistance of the potentiometer while it is connected in the circuit at any time.

INSTRUCTIONS

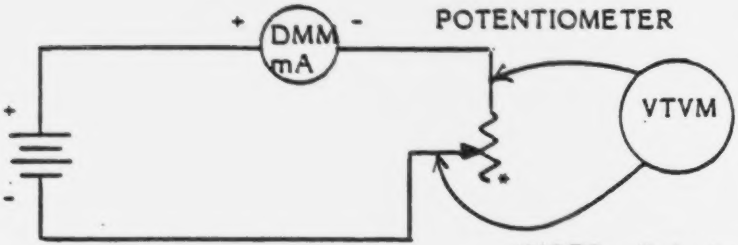
1. Calculate what value of resistance will pass 2 mA with 6.6 volts across it.

Required resistance for 2 mA: _______ohms.

2. Using the DMM ohmmeter -- and with the potentiometer disconnected from the circuit -- set the pot to the resistance calculated in STEP 1.

3. Connect the circuit shown below. Be careful not to change the pot setting.

NOTE: After this we will often use the term "pot" for potentiometer.



Be sure to measure only across the potentiometer, not across the power supply.

*NOTE: Only two of the three potentiometer terminals are connected (center and one end).

4. Increase the power supply voltage across the potentiometer until the DMM milliammeter is reading 2 mA.

5. Measure the voltage with the VTVM across the potentiometer: ______volts.

Is the measured voltage within 10% of the calculated voltage? YES/NO

6. Turn the power supply "off" and remove the potentiometer from the circuit. Set the potentiometer to 220 ohms using the ohmmeter.

7. What voltage will be needed to cause 15 mA to flow through 220 ohms?
__________ volts.

8. Draw the schematic for a circuit to verify your calculations using the power supply, DMM milliammeter, VTVM and potentiometer set to 220 ohms.
HINT: It will be like the circuit in STEP 3.

9. Connect the circuit and verify your calculations. Record the values measured:

Resistance: ______ohms

Current: ______mA

Voltage: ______volts

Did you get the expected results? YES/NO

10. Here is a new situation. What current will flow through a 15kohm resistor with 7.5 volts applied?

__________mA

11. Draw the circuit to verify STEP 10 values, using the same equipment as before.

12. Connect the circuit and make the necessary measurements to verify your calculations. Record your actual measurements:

Resistance: ______ohms

Current: ______mA

Voltage: ______volts

Did you get the expected results? YES/NO

SUMMARY

You should have observed the relationship between voltage, current, and resistance which is mathematically stated in Ohm's Law. Also, you should have gained more experience in connecting circuits correctly and making measurements. At this point in this electronics training program you should be able to do these things without help:

a. Correctly operate the VTVM, DMM, and power supply.

b. Check the continuity of conductors, switches, lamps, and simple circuits using an ohmmeter.

c. Check for "shorts" and "opens" in simple circuits using an ohmmeter.

d. Measure the resistance of fixed and variable resistors using either the VTVM or DMM.

e. Connect a simple circuit of 1 resistor, power supply, and milliammeter.

f. Make a voltage measurement across the resistor and at the power supply.

g. Measure current in a circuit using the DMM milliammeter.

h. Read the resistor color code.

i. Understand that voltage is like "pressure" which forces the current (electrons) through a circuit.

j. Understand that current in any circuit is dependent on the resistance and the voltage in the circuit.

k. Understand the mathematical relationship between voltage, current, and resistance (Ohm's Law).

l. Understand Watt's Law as it relates to power in a circuit.

PROJECT 4: Self Evaluation Quiz

INSTRUCTIONS

Select the correct word to complete the statements below. Do these outside of lab time, and go directly to Lab Sheet #7.

1. If voltage is held constant and resistance is increased in a circuit, the current will______

a. increase. b. decrease. c. remain the same. d. rotate.

2. If voltage is decreased in a circuit with a fixed resistance, current will _____

a. increase. b. decrease. c. remain the same. d. rotate.

3. With a variable resistance and a specific voltage across it, current will increase if ______.

a. the voltage is increased. b. the voltage is decreased.

c. the resistance is increased.

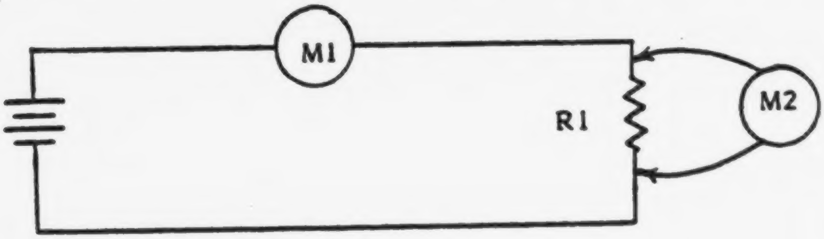
4. When measuring the resistance of a potentiometer with an ohmmeter, the potentiometer must be _____

a. calibrated. b. disconnected from the circuit. c. cool.

5. The VTVM cannot measure ____

a. voltage. b. resistance. c. current. d. DC.

Below is shown a simple circuit with meters. Answer each question based on the indications given on the meters. NOTE: M1 is a milliammeter, and M2 is a voltmeter.



6. M1 indicates 60 mA. M2 indicates 12 volts. What is the resistance of R1?

a. 5 ohms. b. 72 ohms. c. 200 ohms. d. 500 ohms.

7. M1 indicates 0 mA. M2 indicates 24 volts. Probably ____

a. this is normal. b. the resistor is open.
c. The power supply is "off".

8. R1 is 500 ohms. M1 indicates 36 mA. M2 should indicate ____volts.

a. 13.9 b. 18 d. 24

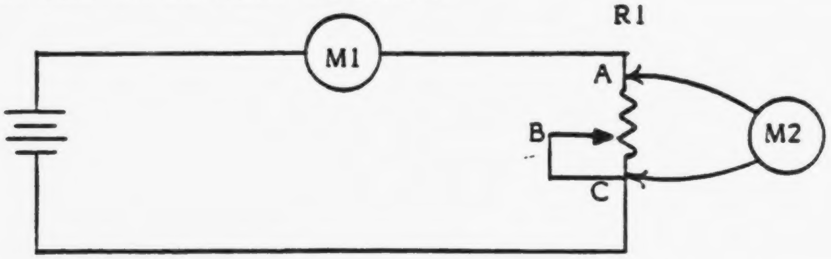
9. R1 is 100kohms. M2 indicates 100 volts. M1 should indicate ____

a. 1 mA b. .01A c. .100A d. 100 mA

10. If the value shown on M1 must be doubled with a fixed resistor, then the M2 indication would be ___

a. halved. b. doubled. c. not changed.

Shown below is another circuit with a potentiometer and meters. Answer each question based on the meter indications.



11. M1 indicates 36 mA. M2 indicates 12 volts. In order to increase the M1 value indicated, R1 slider(B) must be moved toward _____

a. A　　b. B　　c. C

12. M1 indicates 10 mA. M2 indicates 5 volts. If R1 slider(B) is moved toward A, M1 value will _____

a. increase.　　b. decrease.　　c. remain the same.

13. M1 indicates 5 mA. M2 indicates 10 volts. If R1 slider(B) is moved toward C, M2 value will ____

a. increase.　　b. decrease.　　c. remain the same.

14. M1 indicates 33.33 mA. M2 indicates 25 volts. If R1 were removed from the circuit and measured with an ohmmeter, the resistance between A and B would be ______

a. 0 ohms.　　b. 750 ohms.　　c. 825 ohms.　　d. 1.32kohms.

15. R1 is a 1k, 2 watt potentiometer. The position to which slider(B) is set causes M1 to indicate 100 mA. M2 indicates 10 volts. The power dissipated in R1 _____

a. will overheat it.　　b. will not damage it.　　c. cannot be calculated.

Answers to PROJECT 4: Self Evaluation Quiz

1. b
2. b
3. a
4. b
5. c
6. c
7. b
8. b
9. a
10. b
11. a
12. a
13. c
14. b
15. b

Your score: _______

How did you do? Great!　　OK　　Need to study a lot more.

NAME ______________________

Test A OHMS LAW

Directions: Do the following.

1-2. I is the mathematical symbol for ______________, which is measured in ______________.

3-4. The mathematical symbol for voltage is ______________, and is measured in ______________.

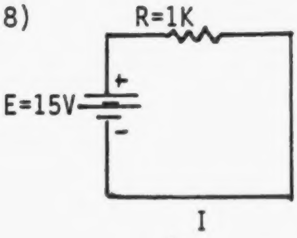
5. What is the relationship between current and voltage in a circuit?

6. Write the mathematical expression of Ohm's Law used for determining the resistance in a circuit.

7. Write the mathematical expression of Ohm's Law used for determining the current in a circuit.

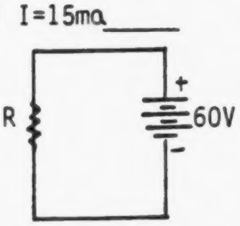
8-12. Solve the following circuit problems:

8)



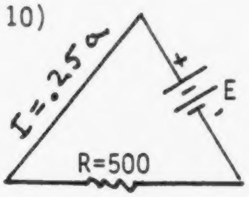
I=_____

9)



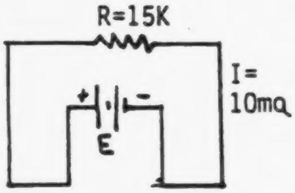
R=_____

10)



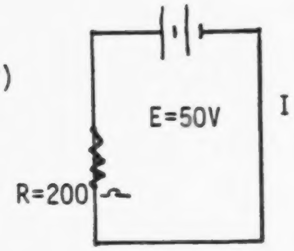
E=_____

11)



E=_____

12)



I=_____

13. Design and draw the schematic of a simple circuit which will function on 27V and have a circuit current of 15 ma.

SCHEMATIC
DIAGRAM

CALCULATIONS

14. Go to Lab station
This QUESTION is worth 6 POINTS

Formula ____________

Solution ____________

Answer ____________

NAME ____________________

Test B OHMS LAW

Directions: Do the following.

1-2. E is the symbol for _______________, which is measured in ____________.

3-4. The symbol for current is _____________, and measured in _____________.

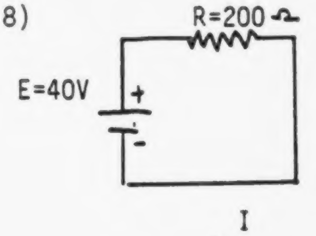
5. What is the relationship between current and resistance in a circuit?

6. Write the mathematical of Ohm's Law used for determining the applied voltage in a circuit.

7. Write the mathematical expression of Ohm's Law for determining the current in a circuit.

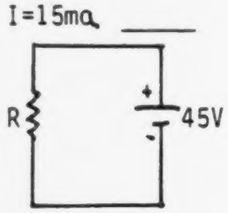
8-12. Solve the following circuit problems:

8)



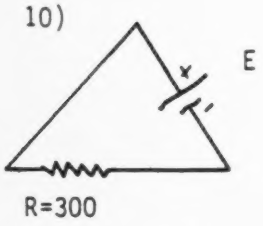
I=_____

9)



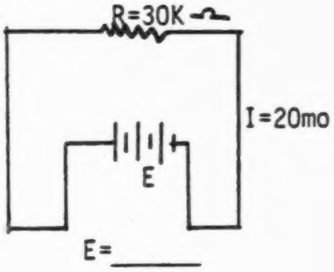
R=_____

10)

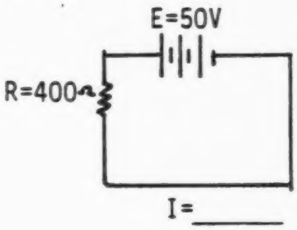


E_____

11)


R=30K Ω
I=20mo
E
E=______

12)


E=50V
R=400Ω
I=______

13. Design and draw the schematic of a simple circuit which will function on 18V and have 9 ma of circuit current.

GLOSSARY

ELECTRONICS

TECHNICAL VOCABULARY

OHM'S LAW

voltage increases
voltage decreases
current increases
current decreases
eng. notation
banana plug
electronics program
genius
DMM measured current
calculated voltage
VTVM measured voltage
slider
milliammeter
schematic representation

GLOSSARY

ELECTRONICS

RELATED GENERAL VOCABULARY

proportional
inversely
memorize
mentally
summary of results
conclusion
verify
minimum
outlined
substitute
construct
designed
accordance
important concepts
devote
column
no matter what
focus
specified
satisfying
rewarding
career
average score
genius
dissipated

Ohm's Law

(ĐỊNH - LUẬT OHM)

MATHEMATICAL:	về toán học
RELATIONSHIP :	sự quan hệ
EXIST :	tồn tại
PROBABLY :	một cách rõ ràng
FUNDEMENTAL :	căn bản
PRINCIPLE :	chính yếu.
APPLICATION :	sự ứng dụng
EXACT :	đúng
CERTAIN :	chắc chắn, rõ, chỉ định.
ACROSS :	xuyên qua.
CONCEPT :	quan niệm, ý niệm.
SOLVE :	giải quyết
CONSTRUCT :	xây dựng, kiến tạo.
VERIFY :	Thử lại
CALCULATION :	sự tính toán.
OPPORTUNITY :	cơ hội, dịp.
HAPPEN :	việc xảy ra
DOUBLED :	được gấp đôi.
CUT IN HALF :	giảm phân nửa
DESIGN :	thành lập, cấu tạo, vẽ kiểu.

SCHEMATIC :	biểu đồ vẽ bằng ký hiệu thay-thế các thành phần cuả mạch điện.
LABORATORY (Lab) :	Thí nghiệm (thường viết tắt là Lab Trong Lab Report)
EXPERIMENT :	Kinh nghiệm
POWER SUPPLY :	Bộ phận cung cấp điện thế tùy theo giá trị mong muốn.
PROCEDUCE :	cách làm
APPLY :	cung cấp
+ TERMINAL :	đầu dây dương + (đỏ)
- TERMINAL :	đầu dây âm − (đen)
(ma) :	ký hiệu chỉ máy đo milliampere
(V) :	Ký hiệu chỉ máy đo điện thế (voltage)
VOLTAGE CONTROL KNOB :	bộ phận hay nút vặn điều chỉnh điện thế cao, thấp.

"ON"	: mở công tắc cho máy chạy
"OFF"	: Tắt (máy, công tắc)
AGREE WITH	: đồng ý với
VTVM	: chữ viết tắt của VACUUM TUBE VOLTMETER. có nghĩa: VOLT KẾ cấu tạo có đèn điện tử để kiểm soát overload.
CHART	: biểu đồ vẽ các ô trị số của điện thế, cường độ, điện trở... theo hàng dọc hoặc hàng ngang

hàng dọc

hàng ngang

	1	2	3	4	T
E	2	4	6	2	14
I					
R					
P					

Thí dụ trên: ta đọc:

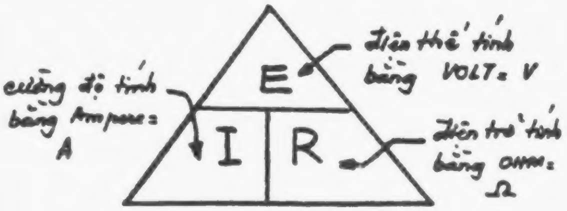
- $E_1 = 2V$; $E_2 = 4V$ $E_3 = 6V$ $E_4 = 2$; E_T : 14 V
- E_T : có nghĩa là E Tổng bởi chữ TOTOL = T.

PLOT	: nghĩ miu kẻ
CURVE	: đường cong
GRAPH	: đồ thị
EXHIBITION	: biểu diễn
SUBSTITUTE	: Thay thế
PROBLEM	: vấn đề, bài toán
PASSING	: qua (nghĩa bóng đậu. Thi đậu)
DIRECTLY PROPORTIONAL	: Tỷ lệ thuận
INVERSELY PROPORTIONAL	Tỷ lệ nghịch
INCREASES	: Tăng
DECREASES	: giảm
EQUATION	: phương trình, đẳng Thức

ĐỊNH - LUẬT OHM: $I = \frac{E}{R}$

biến đổi: $E = I \times R$

$R = \frac{E}{I}$


E
I
R
điện thế tính bằng VOLT = V
cường độ tính bằng Ampere = A
điện trở tính bằng OHM = Ω

AMMETER : một dụng cụ được thiết lập để đo cường độ chạy. Ký hiệu -Ⓐ-

BASIC UNITS : giá trị căn bản của một công thức, một đẳng thức (phương trình). Đơn vị căn bản của định luật OHM là: VOLTS, AMPERES, và OHMS. Nếu bất cứ những chữ này nằm trong các hình thức (KV- kilovolt, mA - milliamere, μA - microampere .v.v) Chúng phải được đổi thành đơn vị căn bản theo thứ tự để nhận được một đáp số đúng và đầy đủ ý nghĩa.

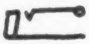
CALIBRATION : phương pháp so sánh hoặc điều chỉnh một dụng cụ, một thước đo theo tiêu chuẩn.

closed circuit : một mạch điện mà nó có một con đường hoàn thành từ cạnh âm của nguồn xuyên qua mạch điện, và trở về cạnh dương của nguồn.

component : một bộ phận của điện hay điện tử như công tắc, điện trở, đèn vv. được dùng trong một mạch điện.

common : một điểm nối trong mạch điện. trong một vài mạch điện dây đất hoặc giàn kim loại (khung) trong hệ thống điện tử cũng được dùng một chỗ nối chung. Ký hiệu ⏚ hay ▽.

DLARSOVAL MOVENT	:	một sự chuyển động của lỏi quay trong máy đo lõi trong máy bị lệch bởi một từ trường không đổi và tỷ lệ với số lượng cường độ qua nó.
Fundamental	:	căn bản
Calibration	:	sự đo (theo tiêu chuẩn qui ước sẵn).
Load	:	gánh vác ; tải điện.
ability	:	năng lực
coil	:	cuộn dây quấn tròn (bên trong có lõi : core)
movement	:	chuyển động
stationary	:	không đổi
magnetic field	:	từ trường
proportional	:	tỷ lệ
meaningful	:	đủ nghĩa.
Deflection	:	sự lệch (Kim)
Incandescent Lamp	:	đèn tròn Ký hiệu : LP
emit	:	phát
filament	:	sợi giây tóc (trong đèn tròn)
Infinity	:	vô cực . Ký hiệu : ∞

Jack	:	phích cắm điện Ký hiệu :  Ký hiệu (chữ) : J.
Receptacle	:	ổ cắm điện
plug	:	phích cắm
Leads	:	dây thử hoặc nối.
attach	:	kết hợp.
proper	:	riêng
Linear scale	:	độ chia đều nhau trên cân.
divisions	:	đơn vị chia trên cân.
incre	:	phần tăng thêm.
mark	:	dấu, ghi dấu.
minimum	:	tối thiểu
maximum	:	tối đa.

multiplier = Range switch.

Needle = Pointer.

Non-linear : sự chia không đều trên cân (ohmmeter)

OHM'S LAW : định luật OHM $E = I \times R$

open circuit : mạch hở.

close circuit : mạch kín.

Parallax : việc nhầm lẫn khi đọc trị số trên cân.

Viewing : tra xét

Potential difference = EMF = E.

Effect : tác dụng

Sensetivity : độ nhạy bén của cân.

full - scale : đầy cân (chỉ kim máy đo lệch đến MAXIMUM)

Short circuit : một con đường có điện trở thấp giữa 2 điểm của 1 mạch điện. Cũng độ quá cao thường gây ra ngẫu nhiên có thể gây thiệt hại mạch điện.

Shunt , mạch rẽ trong Range của máy đo Ampere (Ammeter) nó có điện trở thấp chuẩn xác được đặt trong bộ phận chuyển Range switch dùng để tăng bội.

excessively : thái quá, quá cao.

damage : thiệt hại

precision : chuẩn xác

test probe : lead của máy đo dùng để đo điện, đo điện bằng cách chấm vào chỗ muốn đo.

VOLT DROP : điện thế phân phối hay tụ lại tại một điện trở. VOLTDROP bằng $I \times R = IR$.

Potential	:	điện vị
balance	:	cân bằng
zero adjust	:	sự điều chỉnh kim máy đo về số zero.
Sequence	:	Kết quả, liên phát.
reference	:	tham khảo
guide	:	hướng dẫn
matches	:	tương xứng
Caution	:	cẩn thận
peg	:	dẫm, đập lên
critical	:	nguy cấp
select	:	chọn lựa.
stabilization	:	sự thăng bằng
achieve	:	đoạt được
portion	:	phần
position	:	vị trí
accurate	:	chính xác
vary	:	đổi khác
weak	:	yếu
Reset	:	sắp lại; đặt lại
improper	:	không thích hợp.

recheck	:	Kiểm lại.
tip	:	đầu nhọn
Double	:	gấp đôi; hai lần.
Enter	:	đưa vào; lối vào.
solving	:	giải quyết
definition	:	định nghĩa
energy	:	năng lực
interruption	:	cắt đứt
buzzer	:	còi điện
bell	:	chuông điện
speaker	:	Loa
decreasing (a)		giảm
break (vt)		vỡ, gãy
cell	:	pin
generator	:	máy phát điện.
inspection	:	sự kiểm tra
detected	:	đã khám phá
winding	:	lượn khúc, ngoặt.
remove	:	dời, kéo ra khỏi
suspect	:	nghi ngờ
describe	:	mô tả
matrix	:	cái khuôn
search	:	lục lọi, tìm kiếm.

歐姆定律 (OHM's LAM)

欧姆定律是电流,电压及电阻相互间之基本関係。

欧姆定律述說:在一电路中其电流是对电压(所提供电路之电压)成正比例:

当电压增强-----电流增大
当电压减弱-----电流减小.

又在电路中其电流是对电路上的电阻成反比例:
当电阻增强----电流减小
当电阻减弱----电流增大.

用數學式子表示歐姆定律:

$$I = \frac{E}{R}$$

I = 电路之电流,以安培表示(amperes)
E = 提供之电压,以伏特表示(volts)
R = 电路之电阻,以歐姆表示(ohm)

由上述之數学列式,欧姆定律又可转换另两种列式表示:

或 $E = I \cdot R$
或 $R = \frac{E}{I}$

Ohm's Law : 在1828年由 Geoge Ohm這個科学家所发現的電器学上基本定律（一定的規律）.

mathematical =數学上的.

relationship : 相互関係

proportional to : 对…成比例

directly proportional : 正比例

inversely proportional : 反比例

converted : 轉換。

multiplying : 乘以……

compute : 計算

verify : 證明.證实

off : 切断（関掉）

on : 接通（開）.

supply : 提供

power : 电力.功能.

knob : 轉鈕.

agree with : 同意.

experiment = 实験

Laboratory : (Lab) 实験室

report : 报告.

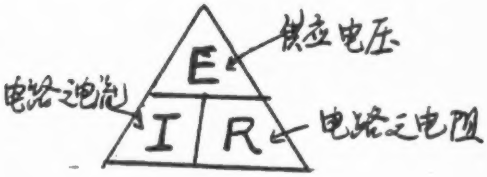
outlined : 绘略图.概說

plot = 用圖面表示.

cure = 曲线.线條.

table = 表，(數字表)

Ma = 即 milliamperes，千分之一安培.



$$E = I \times R$$

$$I = \frac{E}{R}$$

$$R = \frac{E}{I}$$

ELECT CURRICULUM
VOCATIONAL TRAININ SSON PLAN # III Watts Law

Teaching Materials Source ______________________________
Chapter ____________, **pages** ____________________
Lab Manual pages ____________________
Additional Instructor Materials ______________________________

Main concepts student will learn:

The student will be able to:

1. distinguish between the following units of measurement and/or terms; work, joule, watt, power and energy.
2. recite and apply both Ohm's and Watt's Law as requested when solving or evaluating circuits.
3. summarize and discuss power loss as I^2R loss and explain its relationship to heat or power dissipation.
4. differentiate and compare power rating data of appliances or devices, and solve typical electric company bill based on electrical consumption, measurement, and charge rate for electricity.

Technical Vocabulary

Watt
joule
horsepower
power
power rating
power resistor
power dissipation
kilowatt
kilowatt hour

Related General Vocabulary

Materials and Notes

Teaching Activity

1. Distinguish to the class between the concept of useful power versus wasted power and their relationship to this unit. Have students provide examples to illustrate their understanding of the concept. Impress students with the idea that power which is wasted is referred to as dissipated power.
2. The key to this unit is instructor organization of terms presented, be mindful to take care of technical word accuracy.
3. Be careful to watch student performance in formula work especially the handout that contains the Watt's and Ohm's Law Formula Wheel. Mathematics used in completing some of these problems may present a stumbling block for some students. Take some extra time and effort to assist those who cannot square a number, nor find the square root of a given integer.

Length of Lesson

1 week

Evaluation

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of oral or written testing procedures.

WATT'S LAW

OBJECTIVE

1. You will be able to write the relationship between power, current and voltage.

2. Using the symbols for power, current, and voltage, you will be able to write the three mathematical expressions of Watt's Law.

3. Given four carbon resistors of different wattage rating, you will be able to identify the wattage rating of each.

4. Given specific values for two of the three quantities in Ohm's Law, you will be able to solve for power.

5. You will be able to define and use the key index words correctly.

6. Given two of the three values of input power, output power, and efficiency, you will be able to compute the third.

Directions

Do the following

Learning Opportunities	Reasons
Do the following:	
1. Read: Information summary	1. Gives you a "brief" on the things in this package.
2. Look up: Key index words.	2. Learn how to solve circuit problems by use of Watt's Law.
3. Do: Exercise #1	3. Apply Watt's Law to solve actual circuit problems.
4. Do: Exercise #2	4. Apply Watt's and Ohm's Laws to solve actual circuit problems where the resistance is one of the known quantities.

5. Do: Experiment #1	5. Verify the relationship between resistor size and power capability.
6. Do: Exercise #3	6. Apply Watt's and Ohm's Laws to determine the efficiency of an electrical device.

Key Index Words

watt

joule

horsepower

power

power rating

power resistor

power dissipation

kilowatt

kilowatt hour

INFORMATION SUMMARY

1. Mechanical work is force operating through a distance. Mathematically, it is the product of force and distance $W = F \times d$.

2. The unit of work is the joule, which is the work done by 1 newton (N) of force acting over 1 meter (m) of distance.

3. Work is often expressed in foot-pound (ft. lb.) instead of joules.

4. Power is the time rate of doing work, and is expressed in joules per second. (J/s)

5. Mechanical power is frequently expressed as foot-pounds per second (ft. lb./s) and, in larger quantities, as horsepower (hp), with 1 hp equal to 550 ft. lb./s.

6. The electrical unit of power is the watt (W). One watt of power (or heat) is dissipated whenever one volt pushes one amp through a component or a circuit. This is known as Watt's Law and is expressed mathematically as

$$P = IE$$

where P = circuit power measured in watts
I = circuit current in amps
E = applied voltage in volts

7. Watt's Law equation may be transposed into the following forms, which are used for solving circuit problems:

$$I = \frac{P}{E} \qquad E = \frac{P}{I}$$

8. Ohm's Law is combined with Watt's Law to derive two other equations that permit calculation of power in a circuit where only the current and resistance, or voltage and resistance are known.

$$P = I^2R \qquad P = \frac{E^2}{R}$$

9. Mechanical power may be equated with electrical power:

$$1 \text{ hp} = 746 \text{ W}$$

10. The efficiency of a device is the ratio of the output power or energy to the input power or energy required to produce it. It can be expressed as a decimal or as a percentage:

$$\% \text{ Efficiency} = \frac{\text{output power}}{\text{input power}} \times 100$$

11. The total energy transferred by electric current over a period is determined by multiplying power by the time during which it acts. The most common units for energy are the watt·second (or joule) and the Kilowatt·hour (KWh).

12. Resistors are given power ratings, to indicate the maximum values of current or voltage and power dissipation they can safely handle.

13. The power rating of a resistor is directly proportional to its physical size. The larger the resistor the more heat or power it can dissipate.

EXERCISE #1

DIRECTIONS:

Memorize the Watt's Law equations by working the following problems.

1. P =
   I = 2 A
   E = 3 V

2. P =
   I = .5 A
   E = 12 V

3. P = .5 W
   I = 2 A
   E =

4. P = 1 W
   I = .001
   E =

5. P = 2 W
   I =
   E = 50 V

6. P = .25 W
   I =
   E = 5 V

7. P = 10 W
   I = 2 A
   E =

8. P =
   I = .05
   E = 10 V

9. P = .5 W
   I = 5 ma
   E =

10. P =
    I = 20 ma
    E = 20 V

11. P = 2 W
    I = 1 ma
    E =

12. P = .25 W
    I =
    E = 250 V

13. P = .25 W
    I = 125 ma
    E =

14. P = 2 W
    I = .05 A
    E =

15. P =
    I = 50 ma
    E = 500 V

16. P = 10 W
    I = 50 ma
    E =

17. P = 20 W
    I = .5 A
    E =

18. P = .25 W
    I = 2 ma
    E =

Exercise #1 continued.

19. A 115 V electric heater furnishes 1150 W of heat. What is the operating current?

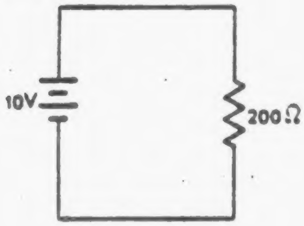
20. What current does the average 115 V 100 W light bulb draw?

EXERCISE #2

DIRECTIONS:

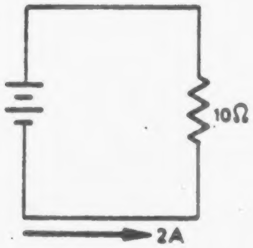
Use Ohm's and Watt's Laws to work the following problems.

①



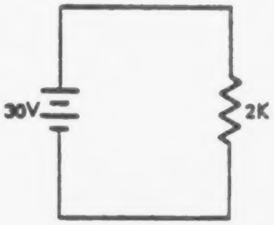
P= ________

②



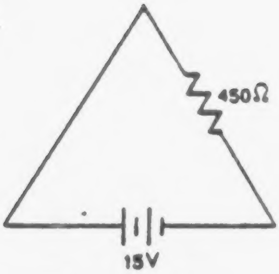
P= ________

③



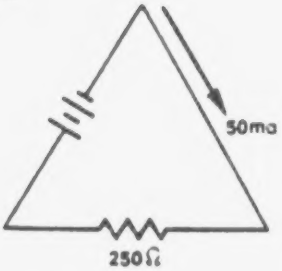
P= ________

④



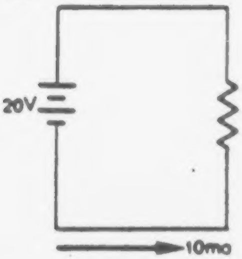
P= ________

⑤



P= ________

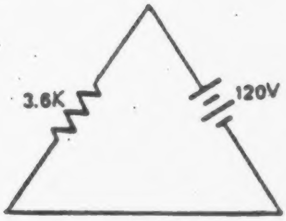
⑥



P= ________

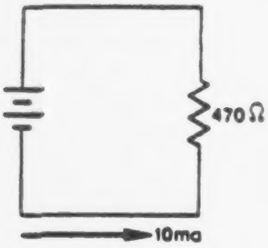
Exercise #2 continued.

⑦



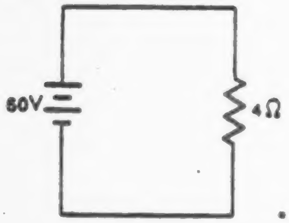
P=________

⑧



P=________

⑨



P=________

10. What power is dissipated in a 200 V heating element having a resistance of 9.52 Ω?

11. A 120 V element electric toaster dissipates 1100 W. What is the resistance of the element?

12. How much voltage must be developed across 660 Ω to dissipate 12.5 W?

13. A resistor has a voltage across it of 12.5V and is dissipating 250 mW. How much current does it carry?

14. A 5 Ω resistance carries a current of 5 A. What power is it dissipating?

15. A 4 Ω radio loud speaker is operating at 2 W input. What is the current in the loud speaker?

16. How much current is needed in a 550 Ω resistor to cause the resistor to dissipate 3.55 kW?

Exercise #2 continued.

17. A 550 V d-c power line is delivering 235 kW to a device. How much current must be flowing?

18. The plate circuit of a vacuum tube operates at 250 V and delivers 2 W. What is the current?

19. What is the power dissipated in a 25 kΩ resistor in which 248 μA is flowing?

20. Which takes more power, a 565 Ω resistor across 150 V or a 10 KΩ resistor across 650 V ?

EXERCISE #3

DIRECTIONS:

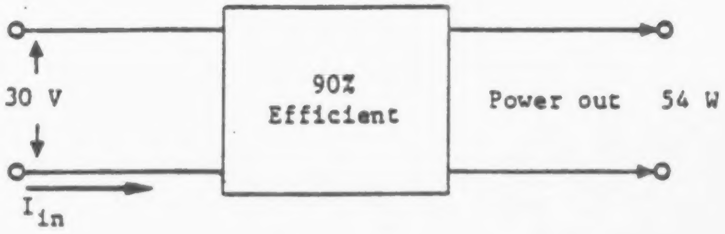
Solve the following problems relating to the efficiency of electrical devices.

1. What is the output power of a device which is 90% efficient and has an input power of 50 W?

2. What is the efficiency of a device having an input power of 12 W and an output power of 9.6 W?

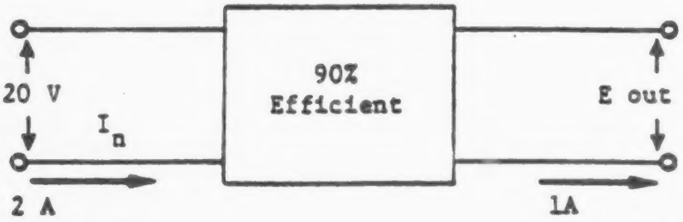
3. What is the efficiency of a device having an output power of 29.4 W and an input power of 30 W?

4. What current will the following device draw?



Exercise #3 continued.

5. What is the output voltage for the following device?



6. What is the efficiency of an electric motor, 115 V, 1 hp, which requires 7 A of current?

7. How much power is lost by heat in the motor in question 6 ?

8. What is the efficiency of a 120 V transformer, which requires .5 A of current in the input primary winding and will furnish 3 A at 18 V at the output secondary winding?

9. What is the efficiency of a electronic circuit which delivers 50 ma at 150 V and draws 2A. from the 30 V power supply?

Exercise #3 continued.

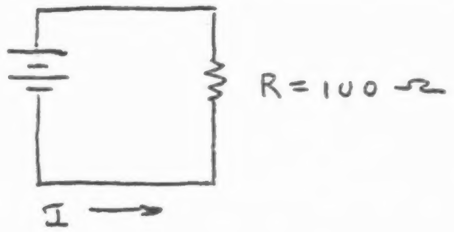
10. What current will a 120 V transformer draw which is 90% efficient, and has an output of 450 V at 100 ma?

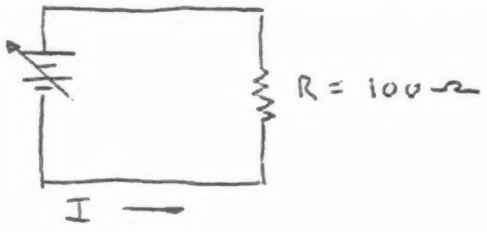
NAME ____________________

DATE ____________ PERIOD ____________

GRAPH WORKSHEET #1
OHMS LAW
WATTS LAW

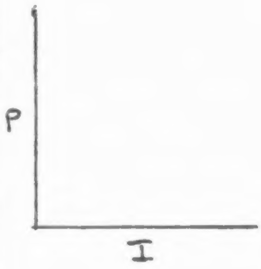
PROBLEM #1 BOTH GRAPHS ON ONE SIDE OF GRAPH PAPER





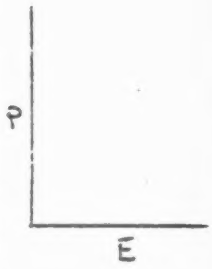
$P = I^2 R$

I	P
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	
4.0	



$P = E^2/R$

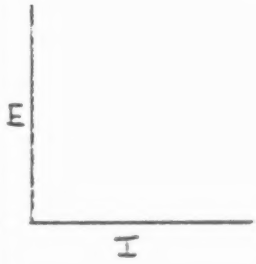
E	P
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	
4.0	



PROBLEM #2 BOTH GRAPHS ON SIDE TWO (BACK) OF GRAPH PAPER

$E = I \cdot R$

I	E
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	
4.0	



$I = E/R$

E	I
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	
4.0	

This will be graded as follows

Neatness of the work	5 pts.
Graph Layout & Proportions	5 pts.
Conclusions	10 pts.

LIST CONCLUSIONS YOU CAN STATE AS A RESULT OF YOUR GRAPHS.

NAME ____________________

DATE ________ PER ________

OHMS LAW & WATTS LAW WORKSHEET.

GIVEN: $E = I \cdot R$ SOLVE FOR I	GIVEN $P = I \cdot E$ SOLVE FOR I
SOLVE FOR R	SOLVE FOR E
GIVEN: $P = I^2 R$ SOLVE FOR R	GIVEN: $P = E^2/R$ SOLVE FOR E
SOLVE FOR I	SOLVE FOR R
GIVEN: $I = \sqrt{P/R}$ SOLVE FOR P	GIVEN: $E = \sqrt{PR}$ SOLVE FOR P
SOLVE FOR R	SOLVE FOR R

WATT'S LAW

NAME______________________________ DATE_________________________

ITEM	ITEM	FORMULA	FORMULA	ANSWER #1	ANSWER #2
2A	47V				
12V	470 Ohms				
1.2Kohm	3W				
.5A	20mW				
9V	2KW				
3mA	4.7KOhms				
1.5A	30V				
110V	10KOhm				
2MOhm	1.5KW				
5mA	2mW				
2.5V	1.3W				
.05mA	5.6KOhm				
.75V	330 Ohms				
86Kohms	.052W				
25uA	12uW				

OHMS LAW FORMULAS NAME______________________

Given: E=IR and P-IE

1. Solve for I in terms of R & E

1. __________

2. Solve for R in terms of E & I

2. __________

3. Solve for I in terms of P & E

3. __________

4. Solve for E in terms of I & P

4. __________

5. Solve for P in terms of I & R

5. __________

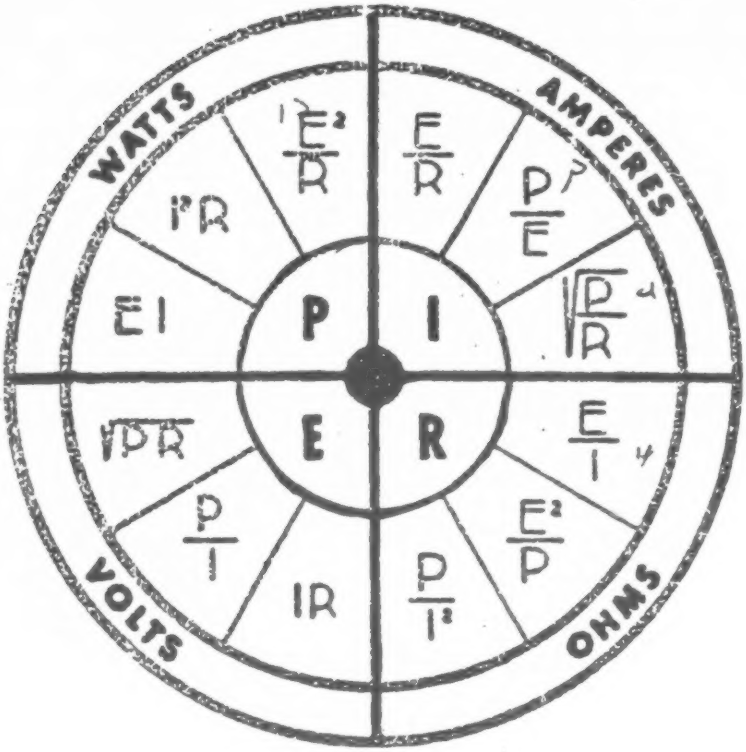
6. Solve for P in terms of E & R

6. __________

7. Solve for R in terms of E & P

7. __________

OHM'S LAW


WATTS
AMPERES
VOLTS
OHMS
P
I
E
R
I^2R
$\frac{E^2}{R}$
EI
$\frac{E}{R}$
$\frac{P}{E}$
$\sqrt{\frac{P}{R}}$
$\sqrt{PR}$
$\frac{P}{I}$
IR
$\frac{E}{I}$
$\frac{E^2}{P}$
$\frac{P}{I^2}$

Self Test

Directions Do the following problems.

90% Accuracy is considered passing for this test.

The mathematical symbol for power is 1) _______________ and is measured in 2) _______________.

The relationship between power and current is 3) _______________; when the current is increased the power 4) _______________.

5) Using mathematical symbols, write the expression for power in terms of current and voltage.

6) Using mathematical symbols, write the expression for power in terms of voltage and resistance.

7) Using mathematical symbols, write the expression for voltage in terms of current and power.

Solve the following problems for the unknown.

8. P =

   E = 40 V

   I = .2 A

9. P = 20 W

   E = 35 V

   I =

10. P = .25 W

    E =

    I = 5 ma

11. P =

E = 18 V

I = 30 ma

12. P = 2 micro W

E = 100 mV

I =

13. P = 75 mW

E =

I = 25 mA

14. Which would have the largest physical size? Resistor #1 10 Ω, 2 W; or Resistor #2 10 K Ω, ½ W.

15. What is the efficiency of an electrical device, which has an input power of 15 W and an output power of 14.7 W?

16. What is the efficiency of a 120 V transformer, which draws .5 A of current in the input primary and delivers 3 A at 17 V from the output secondary winding?

17. What power is lost by heat in the windings of a 1 hp electric motor which is 95% efficient?

18. What current does a 120 V ½ hp electric motor draw if it is 95% efficient?

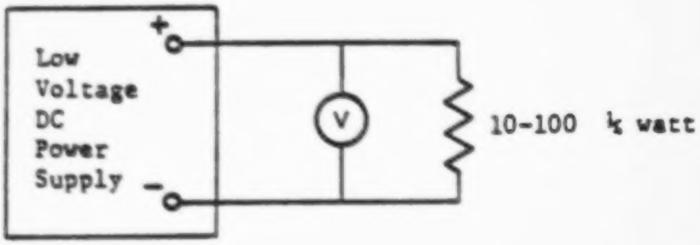
EXPERIMENT

MATERIAL:

1. Low voltage power supply
2. 4 resistors, ¼, ½, 1, and 2 watt
3. (All resistors same value in the range of from 10 to 100 Ω)
3. Voltmeter 0-30 VDC

PROCEDURE:

1. Connect the circuit as shown below using the ¼ watt resistor. Caution: Power "OFF" and observe polarities.



2. For the size resistor being used, compute the maximum voltage which you can apply and still be within the power rating of ¼ watt dissipation.

   Maximum Applied Voltage = ______________________

3. With the voltage control at minimum, turn the power switch to "ON" and raise the applied voltage to about 20% above maximum value. Let the resistor operate at this maximum condition for several minutes while you note the maximum operating condition of a ¼ watt resistor. Carefully touch the resistor with your finger to note its temperature.

4. Raise the applied voltage slowly until the resistor heats and burns open. Note and record the value of the applied voltage when this happens. Note: When the resistor has opened there will no longer be a current path, current will no longer flow, and the resistor will have infinite resistance.

   Applied voltage when resistor opened: ________________

Experiment #1 continued.

5. Compute and record the amount of power that the resistor was dissipating at the time it opened.

   Power dissipation at time of failure: ____________________

6. Reconnect the circuit using a resistor of the ohmic value but having a power rating exceeding that which destroyed the ¼ watt resistor.

7. Apply the same voltage which destroyed the ¼ watt resistor in step 4, noting the operating temperature of the higher wattage resistor.

8. How does the operating temperature of the resistors in step 3 and 7 compare?

NAME____________________
DATE__________ PER______

DATA SHEET FOR POWER Lab.

RESISTOR IN OHMS	RESISTOR POWER RATING	E MAX OF RESISTOR	I MAX OF RESISTOR	E AT 20% OVER POWER RATING	I AT 20% OVER POWER RATING	E AT BURN	I AT BURN	P AT BURN

Name ____________________

Test A

Directions

90% Accuracy is considered passing for this test.

The mathematical symbol for power is 1) ______________ and is measured in 2) ______________.

The relationship between power and voltage is 3) ______________, when the voltage increased the power 4) ______________.

5) Using mathematical symbols write the expression for power in terms of current and voltage.

6) Using mathematical symbols, write the expression for power in terms of current and resistance.

7) Using mathematical symbols, write the expression for current in terms of voltage and power.

Solve the following problems for the unknown.

8) P =	9) P = 16 W	10) P = .5 W
E = 20 V	E = 32 V	E =
I = .5 A	I =	I = 10 ma

11) P =

E = 22 V

I = 50 ma

12) P = .5

E = 50 mV

I =

13) P = 50 mW

E =

I = 5 mA

14) Which would have the largest physical size? Resistor #1 1000 Ω, ½ W; or Resistor #2 50 Ω, 1 W.

15) What is the efficiency of an electrical device, which has an input power of 30 W and an output power of 28.5 W?

16) What is the efficiency of a 120 V transformer, which draws .25 A of current in the input primary and delivers 3 A at 7 V from the output secondary winding?

17) What power is lost by heat in the windings of a 1 hp electric motor which is 90% efficient?

18) What current does a 120 V, ½ hp electric motor draw if it is 90% efficient?

Name ______________________

Test B

Directions

90% Accuracy is considered passing for this test.

The mathematical symbol for power is 1) ____________ and is measured in 2) ____________.

The relationship between power and voltage is 3) ____________, when the voltage is decreased the power will 4) ____________.

5) Using mathematical symbols, write the expression for power in terms of voltage and current.

6) Using mathematical symbols, write the expression for power in terms of voltage and resistance.

7) Using mathematical symbols, write the expression for current in terms of voltage and power.

Solve the following problems for the unknown.

8) P =

E = 30 V

I = 1.5 A

9) P = 18 W

E = 34 V

I =

10) P = .25

E =

I = 5 ma

Test B continued.

11) P =

E = 20 V

I = 15 ma

12) P = 1 W

E = 75 mV

I =

13) P = 80 mW

E =

I = 4 mA

14) Which would have the largest physical size? Resistor #1 100 K Ω, ¼ W or Resistor #2 100 Ω, 1 W.

15) What is the efficiency of an electrical device, which has an input power of 45 W and an output power of 41.4 W?

16) What is the efficiency of a 120 V transformer, which draws 1 A of current in the input primary winding and delivers 3 A at 36 V?

17) What power is lost by heat in the windings of a 120 V 2 hp electric motor, which is 95% efficient?

18) What current does a 120 V ¼ hp electric motor draw if it is operating at 95% efficiency?

GLOSSARY

ELECTRONICS

TECHNICAL VOCABULARY

WATT'S LAW

power capability
joule
horsepower
power rating
power dissipation
kilowatt hour
applied voltage
infinite resistance

GLOSSARY

ELECTRONICS

RELATED GENERAL VOCABULARY

WATT'S LAW

opportunities
key index words
efficiency
foot-pound
instead of
transposed
in terms of

Watt's Law

Input power	:	công suất nhập.
output power	:	công suất phát.
efficiency	:	hiệu suất
brief	:	tóm tắt; ngắn.
actual	:	hiện tại; có thực.
Key index words	:	Khoá chữ hướng dẫn.
size	:	cỡ
capability	:	năng lực
dissipation	:	sự tiêu thụ sự tiêu hao
horsepower	:	mã lực bằng 746 watt
Work	:	công (W)
Force	:	sức; lực (F)
Distance	:	Khoảng cách
W= F x d	:	Công = sức x k cách
foot	:	thước Anh (30,48 cm)
pound	:	Cân Anh (455.54g)
instead	:	thay vì
Newton	:	đơn vị đo (lực; sức)
joule	:	đơn vị của công
transpose	:	chuyển, biến đổi.
derive	:	rút ra

combine	:	kết hợp
permit	:	cho phép
Ratio	:	tỷ lệ
percentage	:	phần trăm
period	:	thời kỳ; thời điểm.
Safely (handle)	:	an toàn (xử dụng)
directly proportional	:	tỷ lệ trực tiếp.
raise	:	tăng lên
condition	:	điều kiện
infinite	:	vô cùng, tối đa, (vô cực)
failure	:	khuyết điểm
exceeding	:	thái quá; cực độ
destroy	:	phá hủy
temparature	:	nhiệt độ
compare	:	so sánh
average	:	trung bình
bulb	:	bóng đèn tròn
draw (vt)	:	được lĩnh; được nhận.
furnish	:	cung cấp
heater	:	máy sưởi.
toaster	:	lò nướng

vacuum tube:	đèn chân không
deliver :	phát ra ; giao hàng
plate circuit:	mạch dương cực: Mạch mà năng lực dương cực của đèn chân không phát tán đi. Có thể gồm cả âm cực, dương cực, tác vụ, nguồn điện và các bộ phận kết hợp.
plate :	dương cực: cực dương của đèn chân không có sức hấp dẫn các âm điện tử.
winding :	bô-bin của máy. (cuộn dây điện trong máy điện hay bộ biến thế).
Input :	công suất hấp thụ; tín hiệu nhập: Công suất hay tín hiệu phân phát tới một bộ phận hay một mạch.
Output :	ngoại suất, xuất tin; năng lực của một mạch điện hay một bộ phận.
Efficiency:	- Hiệu suất (Tỷ số giữa công suất nhập và công suất phát).

$$\% \text{eff} = \frac{\text{output power}}{\text{Input power}} \times 100$$

Ta có thể viết ngắn gọn:

$$\% \text{Eff} = \frac{\text{power out}}{\text{power in}} \times 100$$

瓦特定律(WATT'S LAW)

power :功率.能,

wattage:瓦數(瓦特數)

identify:檢定,驗明

specific values:特定的值.

define:表明,使意義明白.

key:线索,索引表,鑰匙.

index:索引,標誌.

input power:輸入功率.

output power:輸出功率.

efficiency =效能,效率.

brief:簡介.摘要

apply =应用.提供、

actual:真正的,真实的.

joule:焦耳(能量單位)
(watt × second,瓦特×秒)

horsepower:馬力(簡寫為 hp,
(1 hp = 746 watts).

power rating:功率數

power resistor:功率电阻器.

power dissipation:功率耗散

kilowatt:千瓦數

kilowatt hour:千瓦小時.

machanical work:机械功.

newton:牛頓(力的單位、N)

instead of:替代.

push:推动

transposed:移項,移位,互換.

ratio:比.

percentage:百分率

a period:一段時间

physical size:體積(形)之大小.

caution:小心.

minimum：最小.最低值.

turn：轉,扭.

maximum：最大,最高值.

several minutes：好幾分鈡

note：注意.

carefully：小心地

temperature：溫度.

raise：升高.

heats：热

burns open：燒斷.

infinite resistance：无限大电阻.

amount：數量.

failure：无效,失敗.

reconnect：再接线.

compare：比較

memorize：記憶.記住.

heater furnishes：电热装設.

operating：操作

toaster：烤麵包机.

radio loud speaker：收音机擴音器

delivering：帶給,供給

vacuum tube：真空管

across：跨.

device：配件.裝備.

draw：牽,抽導,描畫,吸進.

ELECTRONI RRICULUM
VOCATIONAL TRAININ SON PLAN # IV

Series Resistive Circuits

Teaching Materials Source ______________________________
Chapter ______________, pages ______________
Lab Manual pages ______________
Additional Instructor Materials ______________________________

Main concepts student will learn:

The student will be able to:

- identify series circuits in a diagram and list an example of practical uses for each circuit arrangement.
- solve for total resistance utilizing proper formulas and units of measurement for each circuit discussed.
- explain that voltage is dropped when there is a current flow through a resistance and demonstrate that the voltage drop is directly proportional to the resistance.
- verify calculated values of voltage, current, adn resistance for a series, circuit by assembling a test circuit and measuring quantities with the proper meter.
- recite and apply both Ohm's and Kirchhoff's laws as requested when solving or evaluating circuits.

Technical Vocabulary

series circuit
voltage drop

Related General Vocabulary

Materials and Notes

Teaching Activity

Try this activity "Spell Down": Organize the class into two teams. Using the unit Technical Glossary, the captain of #1 team will call out a term, student #1 , team #2 will spell the word, while student #1, team #1 will define it. Alternate this procedure and judge student performance.

Do not overlook the fact that this unit does assume certain basic mathematical competencies, however, reteaching basic skills will greatly facilitate the disadvantage student. Students sometime find difficulty also in relating to a formula so try and present this concept so that students will view it like responding to a "recipe", the student must follow the recipe to obtain the desired results and any variation may bring disaster.

In addition to formal laboratory experiments, certain laboratory exploration can assist the instructor in vividly illustrating the physical configurations of series, parallel, or extra parts into these positions as a means to familiarize the student with important circuit characteristics.

Length of Lesson

2 weeks

Evaluation

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of oral or written testing procedures.

EL-BC-07 Series Resistive Circuits

BASIC CONCEPTS

INDIVIDUALIZED LEARNING SYSTEMS

Electronics

EL-BC-07 SERIES RESISTIVE CIRCUITS

Circuits, containing two or more resistances with only one path for current flow, are commonly used in electrical circuits for one function or another. They are used to distribute different voltages throughout an electrical system or utilize the same current at different points, such as hi-fi speaker systems using two or more speakers in series or the modern miniature Christman tree lights placed in series on a single conductor.

OBJECTIVE

1. You will be able to write the basic rules and the mathematical expressions (formulas) which pertain to the series circuit, its current, its voltage, its resistance, and its power.

2. Given a series circuit consisting of two or more resistors containing sufficient known values for solution, you will be able to apply the basic rules of a series circuit with Ohm's Law and Watt's Law to solve the circuit for the unknown values.

Directions

If you do not know Watt's Law, read the package covering it before doing this one.

Learning Opportunities	Reasons
1. Read: Information Summary	1. To determine the key information to be learned in the package.
2. Look up: Key Index Words	2. Learn how to apply the basic rules of series circuits to solve circuit problems.
3. Do: Exercise #1	3. Apply the basic rules of a series circuit to solve practical circuit problems.
4. Do: Experiment #1	4. Verify the basic rule for current in a series circuit.
5. Do: Experiment #2	5. Verify the basic rule for voltage in a series circuit.
6. Do: Experiment #3	6. Verify the basic rule for current in a series circuit.
7. Do: Experiment #4	7. Verify the basic rule for power in a series circuit.

Key Index Words.

series circuit

voltage drop

INFORMATION SUMMARY

A series circuit is one in which there is only one path for current flow and all components are connected end-to-end along this path.

The current through any resistance in a series circuit is the same as that through any other resistance in that circuit, and the same as the current through the power supply.

Mathematically this is:

$I_T = I_1 = I_2 = I_3 = \ldots\ldots\ldots I_n$

The total voltage across a series circuit is equal to the sum of the voltage drops across the individual resistances making up the circuit.

Mathematically this is:

$E_T = E_1 + E_2 + E_3 + \ldots\ldots\ldots E_n$

The total resistance of a series circuit is equal to the sum of the resistances of which it is composed.

Mathematically this is:

$R_T = R_1 + R_2 + R_3 \ldots\ldots\ldots R_n$

EXERCISE #1 SOLVING SERIES CIRCUIT PROBLEMS

PROCEDURE:

1. Solution of circuit problems is a two step process.

   Step 1: Determine the total and individual values of current, voltage, and resistance by using Ohm's Law and/or the basic rules for a series circuit.

   Step 2: When step 1 has been determined, the power values may be easily computed by using either Watt's Law or the basic rule for power in a series circuit.

2. Step 1

   a. The first step in analyzing a circuit is to list what you are given. Next, determine what rules, laws, or formulas you can use to solve your problem.

		I	E	R
Values for Total Circuit	Total		200	
Values for Individual Resistors	R_1			200
	R_2			
	R_3		75	300
	R_4			150

Apply Ohm's Law if two values are known on a horizontal line.

Chart 1

Apply rules for series circuit if all but one value is known in a vertical column.

   b. Example problem solution

   1. Examination of the vertical columns show that there are not enough known values to apply any of the basic rules pertaining to current, voltage, or resistance.

   2. Examination of the horizontal lines pertaining to the total circuit and the individual resistors reveals that Ohm's Law may be applied to find the current flowing through R_3. Compute and record in the chart.

Exercise #1, con't

1.

	I	E	R	P
Total		30		
R_1			100	
R_2			50	
R_3			50	

2.

	I	E	R	P
Total		60		
R_1	.2			
R_2			25	
R_3			75	

3.

	I	E	R	P
Total	2			
R_1		40		
R_2			15	
R_3		30		

4.

	I	E	R	P
Total			800	
R1		60		
R_2		40		
R_3		100		

5.

	I	E	R	P
Total		18	9 K	
R_1			3 K	
R_2				
R_3		3		
R_4			4 K	

6.

	I	E	R	P
Total			18 K	
R1	.5ma			
R_2		2.5		
R_3		1		
R_4			9 K	

Exercise #1, con't

3. Applying the basic rule for current gives you the value at all the other currents. Record in chart.

4. You can now apply Ohm's Law to determine the voltage drops for R_1 and R_4. Record.

5. You now have several methods you may use to determine the remaining unknowns. One method is to first apply the basic rule for voltage to determine the voltage drop for R_2. Record.

6. Apply Ohm's Law to determine the resistance of R_2 . Record.

7. Apply the basic rule for resistance to determine the total resistance. Record.

8. The circuit is now solved except for cross-checking your work. This may be done by ensuring that Ohm's Law works for the values on each horizontal line and the basic rules for current, voltage, and resistance apply to the vertical columns.

3. Step 2
Apply Watt's Law to determine the power dissipated by the total circuit and each individual resistance. Record below:

P_T = ____________________

P_1 = ____________________

P_2 = ____________________

P_3 = ____________________

P_4 = ____________________

4. Follow the above procedure to solve the following series circuit problems.

Exercise #1, con't

Directions: Solve the following circuit problems without using the chart method.

7. Find:

E_T = ________ P_T = ________

E_1 = ________ P_1 = ________

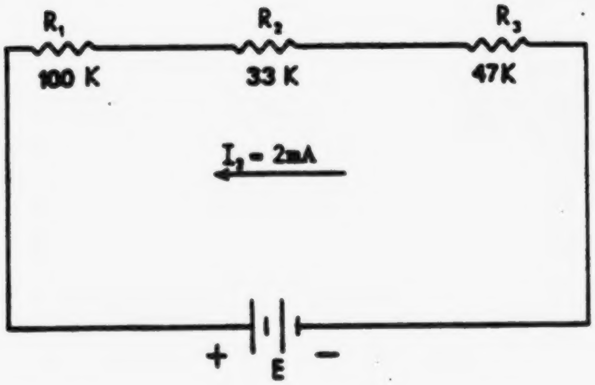
E_2 = ________ P_2 = ________

E_3 = ________ P_3 = ________

I_T = ________ R_T = ________

I_1 = ________

I_3 = ________


R_1
100 K
R_2
33 K
R_3
47K
I_2 = 2mA
+
E
−

8. Find:

R_2 = ________ P_3 = ________

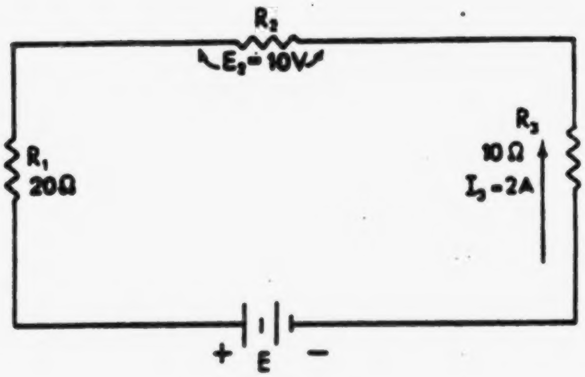
E_T = ________ P_T = ________

E_1 = ________ I_T = ________

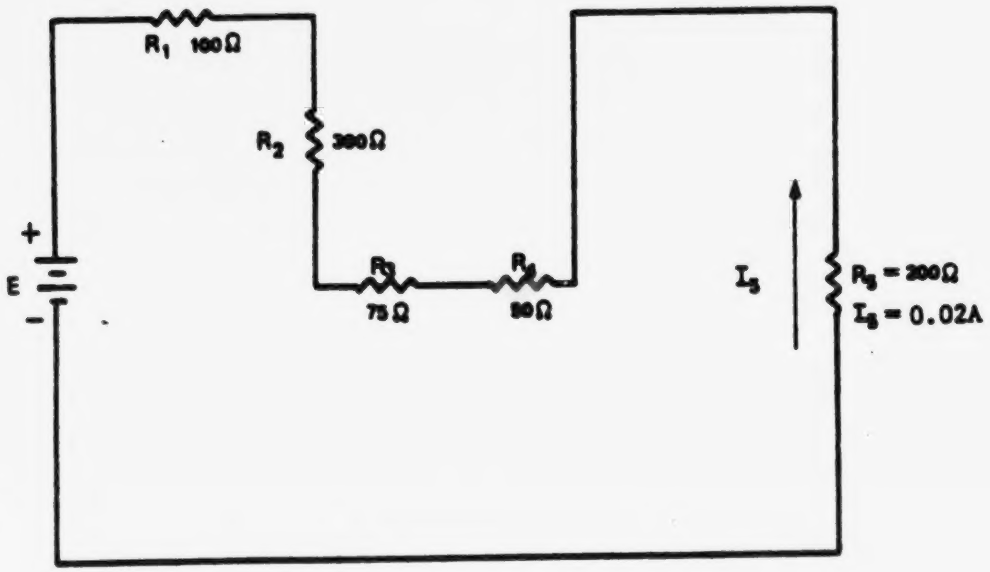
E_3 = ________ I_1 = ________

P_1 = ________ I_2 = ________

P_2 = ________


R_2
E_2 = 10V
R_1
20Ω
R_3
10 Ω
I_3 = 2A
+
E
−

9.


R_1 100Ω
R_2 300Ω
R_3 75Ω
R_4 50Ω
+
E
−
I_5
$R_5 = 200Ω$
$I_5 = 0.02A$

Find: E_T = ______ E_4 = ______ P_1 = ______ P_5 = ______

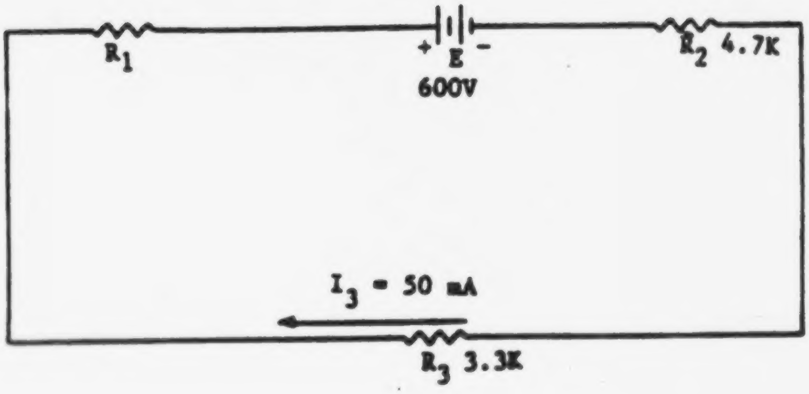
E_1 = ______ E_5 = ______ P_2 = ______

E_2 = ______ I_1 = ______ P_3 = ______

E_3 = ______ I_2 = ______ P_4 = ______

Exercise #1 con't

10.



R_1
+ E -
600V
R_2 4.7K
I_3 = 50 mA
R_3 3.3K

Find:

R_1 = ________ P_1 = ________

E_1 = ________ P_2 = ________

E_2 = ________ P_3 = ________

E_3 = ________ P_T = ________

Name: ____________________

Date: ____________________

Period: ____________________

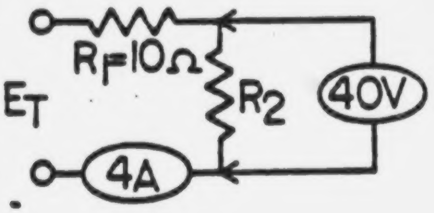
SCORE:

GRADE:

WORKSHEET

SERIES CIRCUIT ANALYSIS #2

Solve the following circuit problems, be certain to show work, and record your answer in the answer box.

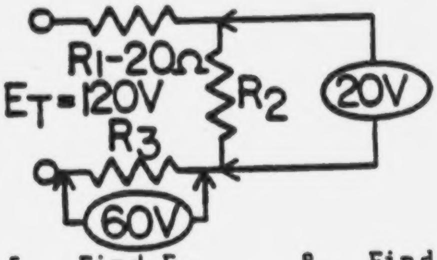


$R_1=10\Omega$
E_T
R_2
40V
4A

1. Find I_{R_2}
2. Find R_2
3. Find E_{R_1}
4. Find E_T

Show work

1.
2.
3.
4.

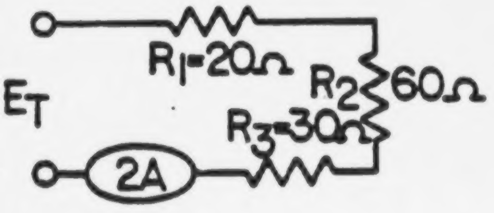


R_1-20Ω
E_T=120V
R_2
R_3
20V
60V

5. Find E_{R_1}
6. Find I_{R_1}
7. Find I_T
8. Find R_2
9. Find R_3

Show work

5.
6.
7.
8.
9.



R_1=20Ω
R_2 60Ω
R_3=30Ω
E_T
2A

10. Find R_T
11. Find E_{R_1}
12. Find E_{R_2}
13. Find E_{R_3}
14. Find E_T

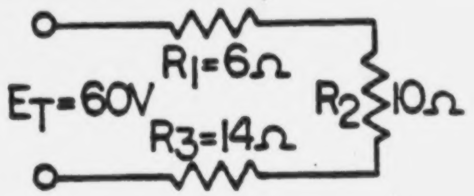
Show work

10.
11.
12.
13.
14.

Name: ______________________

Date: ______________________

Period: ______________________


$R_1 = 6\Omega$
$E_T = 60V$
R_2 10Ω
$R_3 = 14\Omega$

15. Find R_T
16. Find I_T
17. Find E_{R_1}
18. Find E_{R_2}
19. Find E_{R_3}

Show work

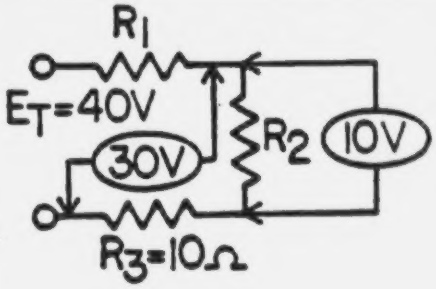
15.

16.

17.

18.

19.


R_1
$E_T = 40V$
R_2
10V
30V
$R_3 = 10\Omega$

20. Find E_{R_1}
21. Find E_{R_3}
22. Find I_{R_3}
23. Find R_2
24. Find R_1

Show work

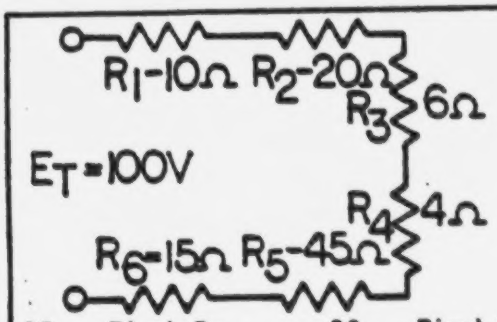
20.

21.

22.

23.

24.


$R_1 - 10\Omega$
$R_2 - 20\Omega$
R_3 6Ω
$E_T = 100V$
R_4 4Ω
$R_6 - 15\Omega$
$R_5 - 45\Omega$

25. Find R_T
26. Find I_T
27. Find E_{R_1}
28. Find E_{R_2}
29. Find E_{R_3}
30. Find E_{R_4}
31. Find E_{R_5}
32. Find E_{R_6}

Show work

25.

26.

27.

28.

29.

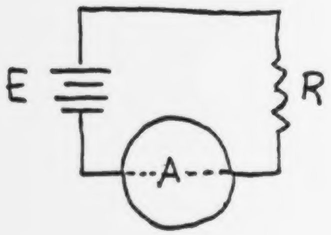
30.

31.

32.

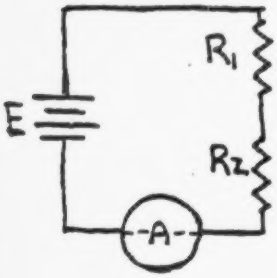
Electronics Sem 1

Solve each problem for the quantity left blank in the chart.



	E	I	R
1	6V	1.7A	
2	9V	3mA	
3	12V	20mA	
4	20V	16μA	
5	40V		645K
6	120V		2.2M
7	6V		300
8	9V		4.7K
9	12V		6.8K
10		1.7A	2.3
11		2.4mA	47K
12		15μA	270K
13		33mA	.7K

	E	I	R_T	R_1	R_2	V_{R1}	V_{R2}
14	12V			4.2K	3.3K		
15	9V			420K	180K		
16	20V			4.7K	6.8K		
17	6V		67K	13K			
18	115V		46		21		
19		3mA		6.3K	10.2K		
20				3K		12V	12V
21		120μA		120K	240K		
22				6.8K		6V	12V
23		2.8A		900	600		
24					10.2K	20V	60V
25		1.6mA				12V	24V



.3 + 10

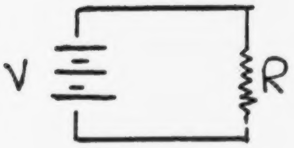


Figure 1

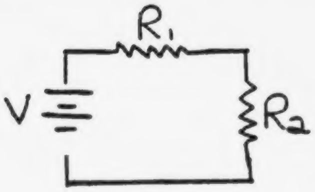


Figure 2

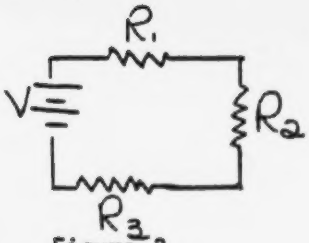


Figure 3

1. V=150v
   R=30K ohms
   I=______

2. V=500v
   I=3A
   R=______

3. I=5.2A
   R=2.3K ohms
   V=______Kv

4. V=1.27mV
   R=4.2K ohms
   I=______uA

5. V=.05Kv
   I=1200mA
   R=______ohms

6. V=1.76v
   R=1.2Meg ohms
   I=______mA

7. A resistor of what size would be required to limit the current flow in a circuit to 4.15mA, if 1.36v were applied?

1. V=100v
   R1=10K ohms
   R2=10K ohms
   I=______uA
   Vr1=____v
   Vr2=____v

2. I=10mA
   R1=470K ohms
   R2=______
   Vr1=______
   Vr2=5.3Kv
   V=______

3. R1=3.6Meg ohms
   Vr1=______v
   R2=______ohms
   Vr2=______v
   V=50v
   I=10uA

4. V=9v
   R1=______v
   Vr1=2.7v
   R2=420 ohms
   Vr2=______
   I=______

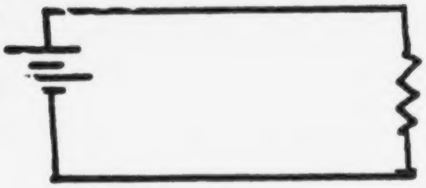
5. I=.3A
   Vr1=5.4v
   R1=______
   R2=22 ohms
   Vr2=______
   V=______

1. R1=200 ohms
   R2=300 ohms
   R3=______
   Vr1=44.44v
   Vr2=______
   Vr3=______
   Rt=______
   I=______
   V=200v

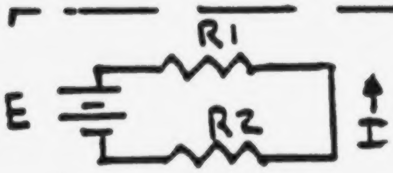
2. R1= 50ohms
   R2= 60ohms
   R3= 80ohms
   Vr1=______
   Vr2=300v
   Vr3=______
   Rt=______
   V=______
   I=______

3. R1=______
   R2=40 ohms
   R3=60 ohms
   Rt=200 ohms
   Vr1=______v
   Vr2=______v
   Vr3=240v
   Vt=______v
   I=______A

E - A Work Sheet Power



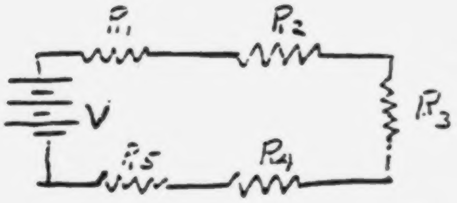
	E	I	R	P_r
1.	6		2.7K	
2.	12	3mA		
3.	18			25mW
4.		6mA	12K	
5.		12.5mA		125mW



	E	R_T	I_T	R_1	R_2	V_{R1}	V_{R2}	P_{R1}	P_{R2}
6.	20V			3K	6K				
7.				12K		36V	72V		
8.		25K			10K	24V			
9.	16V		32mA		150Ω				
10.			12.5mA					25mW	50mW
11.	12V			4.7K	6.8K				
12.				340		12.6V	6.3V		
13.		3.7K			1.2K		7V		
14.	36V		25μA	680K					
15.			8mA					36mW	12mW

SERIES CIRCUIT PROBS. #4

Fig. #1



#1 Vt=-----V Vr3=-----V
It=----mA Vr4=-----V
Rt= 12K ohms Vr5= 9.9V
R1= ----ohms Ir1=----mA
R2= 1800 ohms Ir2=-----A
R3=------ ohms Pr1=.0216Watts
R4=------ ohms Pr2=----mW
R5=------ ohms Pr3=----W
Vr1= 7.2 V Pr4=.0081W
Vr2=-----V Pr5=-----mW

#2 Vt=2KV Vr2=.2KV
It=----A Vr3= 600V
Rt=----Ohms Vr4=----V
Pt= 1KW Vr5=750V
R1=800 ohms Ir3=----mA
R2=---- Pr1= 200W
R3= 1.2K ohms Pr2=.1KW
R4=----- Pr3=-----W
R5=1500 ohms Pr4=-----W
Vr1=-----V Pr5=----KW

#3 Vt=------V Vr3=-----V
It=------A Vr4= 44V
Rt=------Ohms Vr5= 1 V
Pt=------Watts Ir1=----A
R1= 500 ohms Ir2=---mA
R2=---- ohms Pr1=----W
R3= 3.3K ohms Pr2= 96mW
R4=------ ohms Pr3=-----W
R5=------ ohms Pr4=----mW
Vr1=----- V Pr5=2000uW
Vr2=----- V

#4 Vt=18V Vr3=5.4V
It=----uA Vr4=----
Rt=----Ohms Vr5=----
Pt=----W Pr1=-----uW
R1=.68 Meg ohm Pr2=6.09192uW
R2=----K ohms Pr3=------W
R3=----ohms Pr4=------W
R4=----K ohms Pr5=17.7552uW
R5=1.37Meg ohms
Vr1=------V
Vr2=------V

EXPERIMENT

EXPERIMENT #1

CURRENT IN A SERIES CIRCUIT

MATERIALS - EQUIPMENT

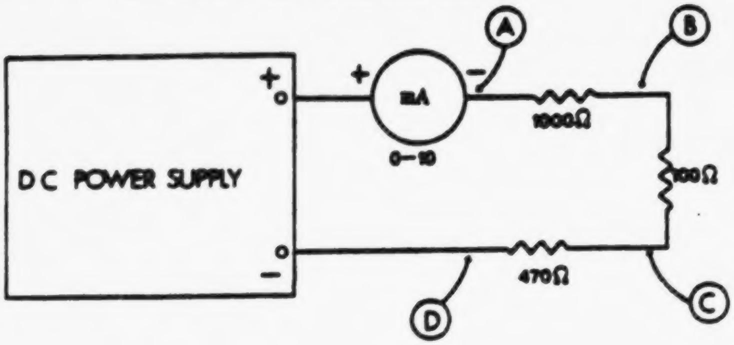
Low voltage DC power supply
100 Ω resistor
470 Ω resistor
1000 Ω resistor (or values close to these)
0-10 ma meter

PROCEDURE:

1. The basic rule to be verified for current in a series circuit is:

2. The mathematical expression for the current basic rule is:

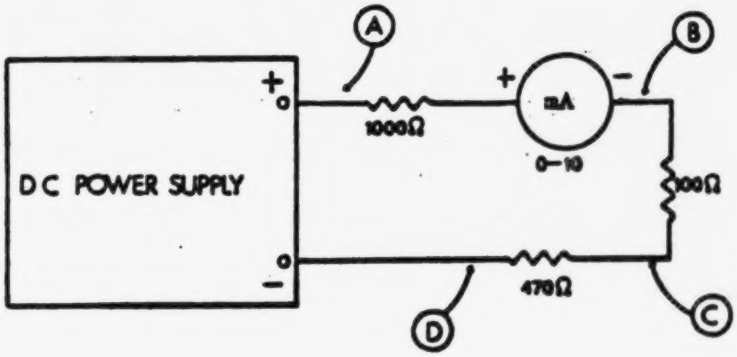
3. Verification of the above rule will be by connecting a circuit and measuring the current at various points in the circuit to see if the rule applies.
   a. With the power switch "off", and the voltage control turned to minimum, connect the following circuit to measure the current at point A. Caution: Observe polarities.



Experiment #1, con't

b. Slowly apply a voltage to the series circuit by turning the voltage control knob until the milliammeter indicates 5 ma.

c. Turn the power supply "off" and move the milliammeter to measure the current flowing at point B between the 1000 Ω and 100 Ω resistors. Caution: Do not change the applied voltage. Circuit should now be as follows:



d. Turn power switch "on". Read and record current flowing at point B = ________________.

e. Repeat steps c and d above to measure the current flowing at points C and D.

I at point C = ______________

I at point D = ______________

4. Did the experiment verify the basic rule for current in a series circuit? If so, how?

EXPERIMENT #2

VOLTAGE IN A SERIES CIRCUIT

MATERIALS AND EQUIPMENT:

Low voltage DC power supply
100 Ω resistor
470 Ω resistor
1000 Ω resistor
DC voltmeter

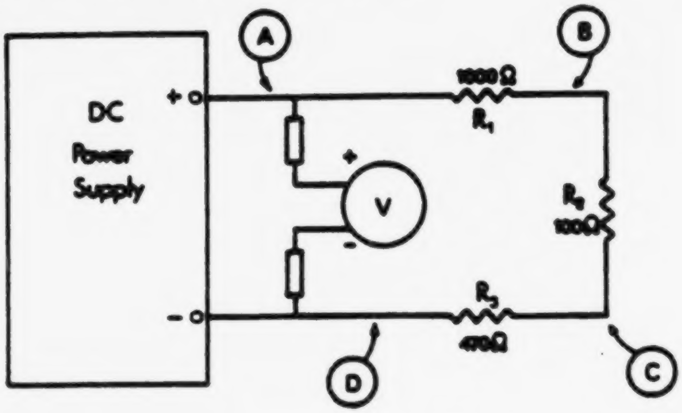
PROCEDURE:

1. The basic rule to be verified for voltage in a series circuit is:

2. The mathematical expression for the voltage basic rule is:

3. Verification of the above rule will be by connecting a circuit and measuring the voltage drops and the applied voltage to see if the rule applies.

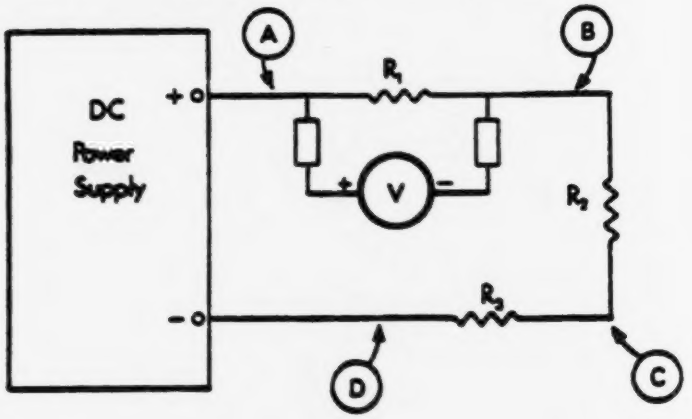
    a. With the power switch "off", and the voltage control at minimum, connect the following series circuit.



Experiment #2, con't

b. Turn the power switch "on" and adjust the applied voltage to a measured 30 v.

c. Change the voltmeter leads to measure the voltage drop across R_1 the 1000 Ω resistor. Caution: Observe polarity by placing the positive probe of the voltmeter on the end of the resistor towards the positive terminal of the supply voltage as follows:



Record the voltage E_1 = __________

d. Repeat step c to measure the voltage drops across R_2 and R_3; Record.

E_2 = __________ E_3 = __________

e. The sum of the voltage drops equals __________

f. Did the experiment verify the basic rule for voltage in a series circuit? If so, how?

g. Note: The voltage may be measured between any two points in the circuit and will be equal to the sum of the voltage drops between these two points. To prove this, measure and compare the voltage between the following

Experiment #2 con't

two points with the voltage drops previously measured.

From Point (Negative probe)	To Point (Positive probe)	Sum of measured voltage drops	Measure voltage
D	B	$E_2 + E_3$ __________	__________
C	A	$E_2 + E_1$ __________	__________

EXPERIMENT #3

RESISTANCE IN A SERIES CIRCUIT

MATERIALS AND EQUIPMENT:

Ohmmeter
(2) 100 Ω, 270 Ω, 470 Ω resistors

PROCEDURE:

1. The basic rule to be verified for resistors in series is:

2. The mathematical expression for the resistance basic rule is:

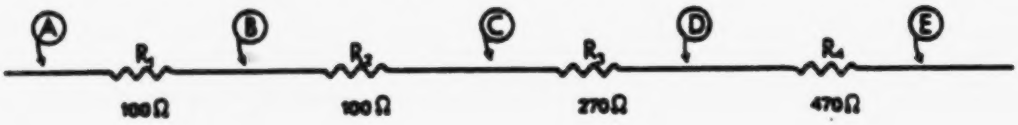
3. Verification of the above rule will be to connect measured resistances in series and measure their combined effect to see if the rule applies.

   a. With an ohmmeter, measure and record the resistance of the following individual resistors.

Resistor	Rated Value	Measured Value
R_1	100 Ω	________
R_2	100 Ω	________
R_3	270 Ω	________
R_4	470 Ω	________

Experiment #3 con't

b. Connect the resistors in series as follows:



c. Measure and record the total resistance of the series circuit from point A to E.

R_T = ________________

d. Does this verify the basic rule for resistance in a series circuit? If so, how?

e. Note : The resistance between any two points of a series circuit may be measured without disconnecting the circuit as there is no other path for current flow between the two points.

To prove this, measure the resistance between the following two points and compare this with the resistance of the resistors connected between these points.

From Point	To Point	Rated Resistance	Measured Resistance
A	C	200 Ω	________
A	D	470 Ω	________
B	C	100 Ω	________
B	D	370 Ω	________
B	E	840 Ω	________
C	D	270 Ω	________
C	E	740 Ω	________

c. Calculate the total power being dissipated by the circuit.

$P_T = E_T I_T =$ ____________________

d. Measure the voltage drop across R_1. $E_1 =$ ____________________

e. Calculate the power dissipated by R_1. $P_1 = E_1 I_1 =$ ____________________
(Remember the basic rule for current)

f. Measure the voltage drops across each of the resistors and calculate the power being dissipated. Record:

$P_2 = E_2 I_2 =$ ____________________

$P_3 = E_3 I_3 =$ ____________________

$P_4 = E_4 I_4 =$ ____________________

g. Does the above verify the basic rule for power in a series circuit? If so, how?

EXPERIMENT #4

POWER IN A SERIES CIRCUIT

MATERIALS AND EQUIPMENT:

Low voltage DC power supply
(2) 100 Ω, 270 Ω, 470 Ω resistors
Voltmeter

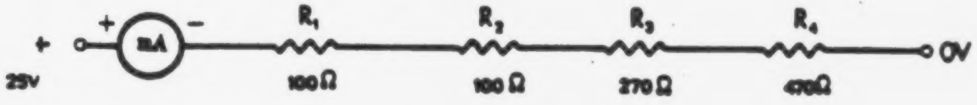
PROCEDURE:

1. The basic rule to be verified for power in a series circuit is:

2. The mathematical expression for the power rule is:

3. Verification of the above rule will be made by computing and comparing the total power dissipated in a series circuit with the power dissipated by the individual resistances.

   a. Connect the following circuit inserting a milliammeter to measure the total current flowing.



   b. Apply 25 V, measure total current ________________

SERIES CIRCUITS

Lab Sheet #7

OBJECTIVES

To learn the main characteristics of a series circuit
To learn how to measure voltage and current in a series circuit
To learn how to troubleshoot a series circuit

MATERIAL

Resistors: 220, 470, 560, 1k, 3.3k, 4.7k, (2)10k, and 2 which add up to 3k
VTVM OR VOM
DMM
Solderless Breadboard

INTRODUCTION

You will be connecting resistors to form a series resistive circuit. Then you will make voltage and current measurements to verify the theory that you have studied. Be sure to read the reading assignment before starting.

The major RULES you will be concerned with are these:

1. The total circuit resistance in a series circuit is equal to the sum of the individual resistances:

$$R_T = R1 + R2 + R3 \ldots.$$

2. The current at any point in a series circuit is the same. Total current(I_T) is a function of the applied voltage(E_{APP}) and the total resistance(R_T):

$$I_T = \frac{E_{APP}}{R_T}$$

3. The voltage across each individual resistor(E_R) is equal to the product of the current times the resistance of that resistor.

$$E_{R1} = I_{R1} \times R1 \quad \text{and} \quad E_{R2} = I_{R2} \times R2$$

4. The voltage across each resistor is proportional to the amount of resistance each contributes to the total resistance:

$$E_{R1} = \frac{R1}{R_T} \times E_{APP} \quad \text{and} \quad E_{R2} = \frac{R2}{R_T} \times E_{APP}$$

5. The sum of the voltages across each resistor is equal to the applied voltage:

$$E_{APP} = E_{R1} + E_{R2} + E_{R3} \ldots\ldots$$

6. The total power(P_T) dissipated in the circuit is equal to the sum of the power dissipated by the individual resistors:

$$P_T = P_{R1} + P_{R2} + P_{R3} \ldots\ldots$$

7. The total power dissipated by all the resistors in the circuit is equal to the power provided by the power supply.

$$P_T = P_{APP}$$

NOTE: All the RULES above are very important to learn before going to the next Lab Sheet: Parallel Circuits. As you do the following projects, take the time to understand the relationships between voltage, current, and resistance in series circuits. Refer back often to the RULES and the formulas until you know them completely. Be sure to study the chapter in your textbook on SERIES CIRCUITS until you are completely familiar with all the concepts.

It may help to know at this point that you will be studying SERIES CIRCUITS in this Lab Sheet and PARALLEL CIRCUITS in the next. These two circuit configurations can be combined to form SERIES-PARALLEL CIRCUITS. All electronic circuits are one of these three configurations. If you are to be an effective electronic technician, it is essential to understand all of the concepts, rules, and formulas governing these three circuit configurations.

PROJECT 1: Total Resistance in a Series Circuit.

INTRODUCTION

In this project you should observe that $R_T = R1 + R2 + R3$.

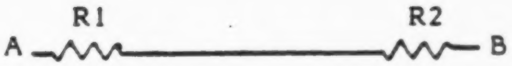
INSTRUCTIONS

1. Select two resistors from your Parts Kit which have a combined total resistance of approximately 3000 ohms when connected in series. (Get as close to 3kohms as possible.)

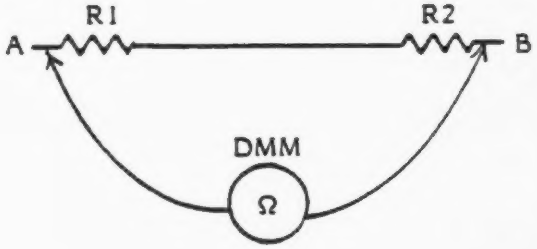
2. Designate the smaller value resistor "R1" and the bigger one "R2". Record below the Color Coded Resistance value of each plus the tolerance %. Using the DMM, measure and record the resistance of each resistor.

	Color Coded Resistance	Tolerance %	Measured Resistance
R1			
R2			

3. Connect the two resistors in series, as shown below, on your solderless breadboard. The ends of the "circuit" will be designated "A" and "B" as shown.



4. Connect the DMM ohmmeter to points "A" and "B" as shown below.

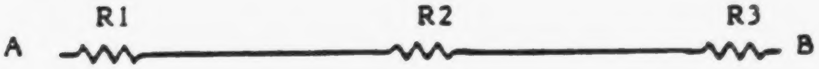


5. Record the DMM measurement. This is the total circuit resistance(R_T). Does it equal the sum of R1 + R2? YES/NO

6. Select a third resistor from the Parts Kit with a color coded value of 3.3kohms. It will be designated R3 in this circuit. Measure and record the resistance.

R3: ________

7. Connect R3 in series with R1 and R2 as shown below.



8. Calculate the total circuit resistance(R_T): ________

9. Measure the total circuit resistance(R_T): ________

10. Is the measured R_T the same as the calculated R_T? YES/NO

SUMMARY

You should have observed this relationship:

$$R1 + R2 + R3 = R_T$$

PROJECT 2: Current in a Series Circuit

INTRODUCTION

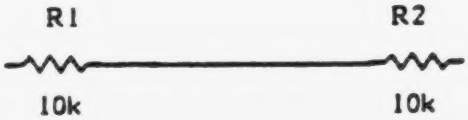
In this project you should observe the effect of voltage and resistance on current in a series circuit. You should also recognize that current in a series circuit is the same at every point.

INSTRUCTIONS

1. Locate, measure, and record the resistance of two 10kohm resistors:

R1: ________kohms R2: ________kohms

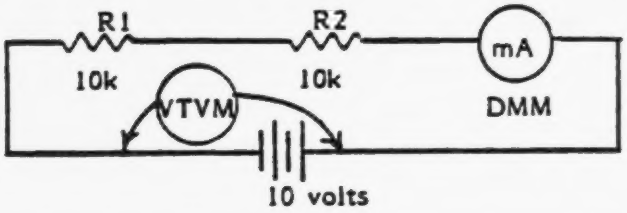
2. Connect the circuit below.



3. Calculate the total current that should flow if 10 volts is applied.

$$I_T = \frac{E_{APP}}{R_T} = \underline{\hspace{3cm}} \text{mA}$$

4. With the power supply "off", connect it and the DMM milliammeter as shown below. Do not turn the power supply "on" until directed.

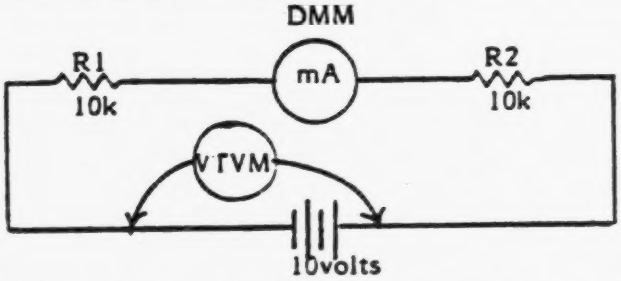

R1
10k
R2
10k
mA
DMM
VTVM
10 volts

5. Make sure the power supply voltage control knobs are turned fully counterclockwise. Turn the power supply "on".

6. While monitoring the DMM milliammeter to make sure too much current does not flow, slowly raise the voltage to 10 volts as indicated on the VTVM. Record the current flow at 10 volts:

I_T: ________mA

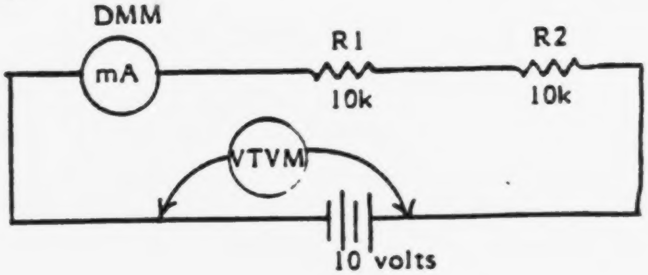
7. Turn the power supply "off" and relocate the DMM milliammeter to the point between R1 and R2 as shown below.


DMM
R1
10k
mA
R2
10k
VTVM
10volts

8. Repeat STEPS 5 and 6 with the milliammeter at this new point in the circuit.

I_T: ________mA

9. Turn the power supply "off" and relocate the DMM milliammeter to the point shown below.


DMM
mA
R1
10k
R2
10k
VTVM
10 volts

10. Repeat STEPS 5 and 6 again.

I_T: ________mA

11. Did you get the same amount of current flowing at each of the three different points in the series circuit?

$I_T = I_{R1} = I_{R2}$ YES/NO

Did the amount of current flowing follow Ohm's Law?

$I_T = \frac{E_{APP}}{R_T}$ YES/NO

PROJECT 3: Voltage Drops in a Series Circuit

INTRODUCTION

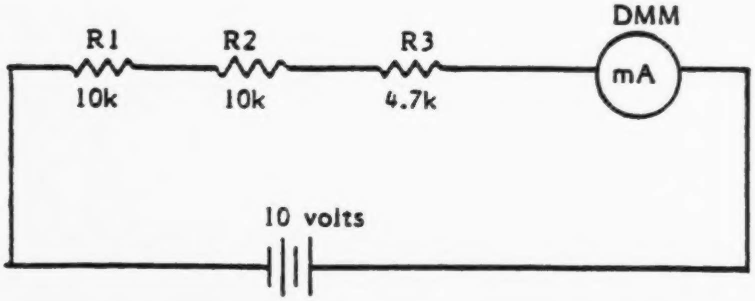
This project should help you to better understand RULES 3 and 4 stated in the INTRODUCTION on page 1. These two concepts are extremely important and must be understood.

INSTRUCTIONS

1. Locate, in your Parts Kit, and measure the resistance of these resistors:

Color Coded Value	Measured Value	Circuit Designation
10kohms	________	R1
10kohms	________	R2
4.7kohms	________	R3

2. Connect the resistors as shown below. Do not turn the power supply "on" until directed.



3. Calculate the total resistance(R_T) and the total current(I_T) in the circuit.

$$R_T = R1 + R2 + R3 = \_\_\_\_\_\_\_\_ \text{ohms.}$$

$$I_T = \frac{E_{APP}}{R_T} = \_\_\_\_\_\_\_\_ \text{mA}$$

4. Turn the power supply "on" and verify the total current flowing. Is it the same as calculated? YES/NO

5. Calculate the voltage drop across each resistor. Record below.

$$E_R = I_T \times R$$

NOTE: In this formula:

R is the RESISTANCE of one specific resistor (R1, R2, or R3).
E_R is the VOLTAGE across that specific resistor.
I_T is the CURRENT through that resistor and the circuit.
Use only measured values for highest accuracy.

E_{R1}: ________volts.

E_{R2}: ________volts.

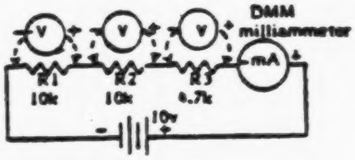
E_{R3}: ________volts.

6. Turn the power supply "on" and apply exactly 10.0 volts to the series circuit as shown. Using the VTVM, measure the voltage across each resistor. Record below.

E_{R1}: ________volts.

E_{R2}: ________volts.

E_{R3}: ________volts.



7. Are your measured values close to your calculated values? YES/NO

8. Try RULE 4 from the INTRODUCTION on the above circuit:

$$E_R = \frac{R}{R_T} \times E_{APP},$$ where R is any specific resistor (R1, R2, or R3).

E_{R1}: ________volts.

E_{R2}: ________volts.

E_{R3}: ________volts.

Do you get close to the same answer as in STEP 6? YES/NO

9. RULE 5 in the INTRODUCTION is easy but very important. Does the sum of the three voltage drops equal the applied voltage? YES/NO

10. RULE 6 deals with the power dissipated in the circuit. It is expressed mathematically like this:

$$P_T = P_{R1} + P_{R2} + P_{R3}\ldots,$$

where $P_T = \dfrac{E^2_{APP}}{R_T} =$ ____________ mW,

and

$$P_R = \frac{E^2_R}{R}$$ (where R is R1, R2, or R3).

Now calculate the power dissipated in the three resistors, using the formula immediately above, and add them together. Does the sum equal P_T?

YES/NO

PROJECT 4: Practice in Working with a Series Circuit

INTRODUCTION

You will be connecting and testing a series circuit without being given detailed instructions. Be sure to work with this project until you and your lab partner completely understand all the rules and concepts.

INSTRUCTIONS

1. Locate and measure the resistance of these resistors from your Parts Kit:

Color Coded Resistance	Measured Resistance	Circuit Designation
220 ohms	________ ohms	R1
470 ohms	________ ohms	R2
560 ohms	________ ohms	R3
1000 ohms	________ ohms	R4

2. Draw a series circuit with these resistors in order listed. R1 is closest to the "-" of the power supply. There is no ammeter in this circuit. There are 10 volts applied by a power supply.

3. Calculate what voltage will be across each resistor. Record below.

CALCULATED

E_{R1}: _______ volts

E_{R2}: _______ volts

E_{R3}: _______ volts

E_{R4}: _______ volts

4. Apply power to the circuit and measure the voltage across each resistor. Record.

MEASURED

E_{R1}: _______ volts

E_{R2}: _______ volts

E_{R3}: _______ volts

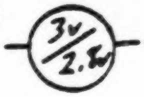
E_{R4}: _______ volts

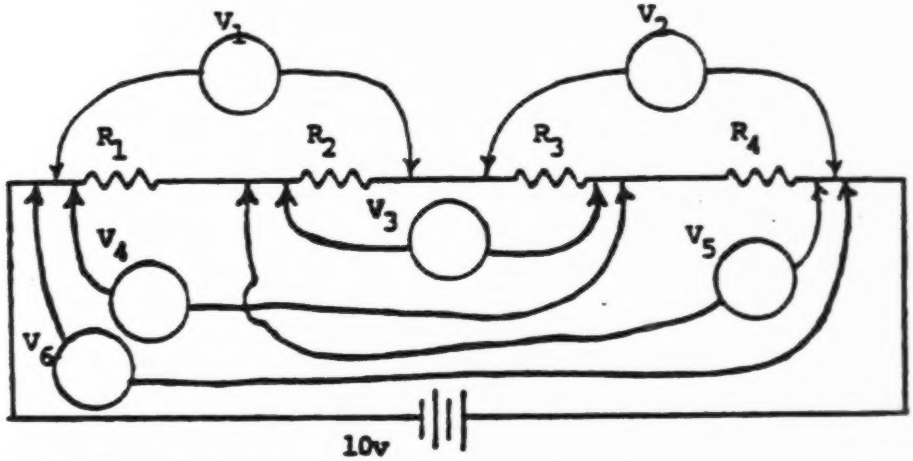
5. Does the sum of the individual voltage drops equal the applied voltage?

YES/NO

6. Which RULE and formula shows that the current is the same in each resistor?

7. Below is a schematic of your series circuit plus 6 voltmeters. Calculate how much voltage each voltmeter should indicate. Write the voltage in each meter above the slash(/). Then measure the voltage and write it below the slash. Example: calculated/measured.





NOTES: Observe that meter V_1 will show the voltage drop across R1 plus the voltage drop across R2. This could be designated as $E_{R1} + E_{R2}$. Study carefully all the relationships indicated by each meter. For example, do you recognize this: $E_{R1} + E_{R2} + E_{R3} + E_{R4} = E_{APP}$? Stated another way: $V_1 + V_2 = V_6$.

8. Write the rule for V_4. ______________________________

9. Write the rule for V_5. ______________________________

10. Apply power and measure the voltages where indicated by each meter. Record in the meter below the slash.

11. Does V_3 follow this rule: $E_{R1} + E_{R2}$? YES/NO

12. Does V_4 follow your rule in STEP 8 above? YES/NO

13. Does V_5 follow your rule in STEP 9 above? YES/NO

PROJECT 5: Series Circuits with an "OPEN"

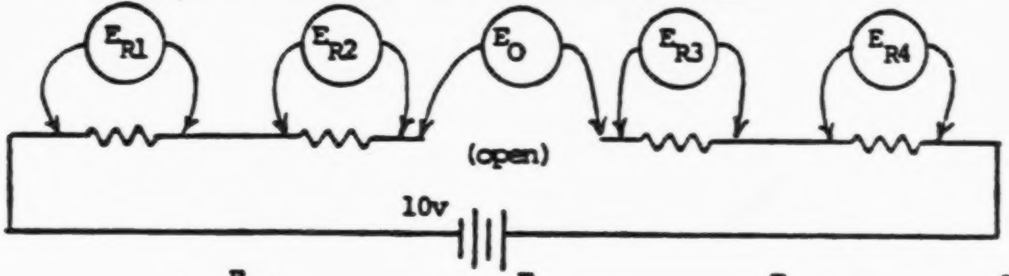
INTRODUCTION

When a series circuit "opens" due to a failure of a component, all current stops flowing. All the RULES in the INTRODUCTION are still valid if you consider the "OPEN" to be a resistor with infinite ohms resistance. You will find this concept important when troubleshooting series circuits. For example, you will find that when a circuit is "open" all the applied voltage is measured across the "open". Try to recognize exactly how this is consistent with all of the rules when the "open" is considered to be a resistor of infinite ohms.

INSTRUCTIONS

1. Using the same circuit that you used in PROJECT 4, "open" the circuit between R2 and R3 (that is, remove the clip lead between R2 and R3).

2. With 10 volts applied, measure the voltage across each resistor and the "open" as shown below. Record where indicated below.



E_{R1}__________V E_{R2}__________V E_O__________ E_{R3}_______V E_{R4}_______V

3. Check your results with each RULE in the INTRODUCTION. Are they still true for this special case when there is an "open"?

Is RULE 1 true? YES/NO

Is RULE 2 true? YES/NO

Is RULE 3 true? YES/NO

Is RULE 4 true? YES/NO

Is RULE 5 true? YES/NO

Is RULE 6 true? YES/NO

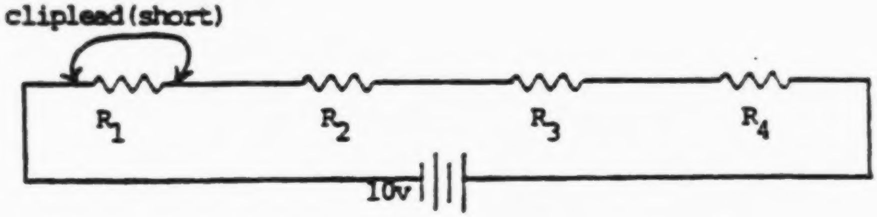
PROJECT 6: Series Circuit with a "SHORT"

INTRODUCTION

If we consider a "short" to be a resistor with 0 ohms, all of the RULES in the INTRODUCTION still are true. This will be important to you as a technician troubleshooting a series circuit with a "short".

INSTRUCTIONS

1. Reconnect R2 and R3 with the clip lead in the series circuit used for PROJECT 4. Connect another clip lead from one end of R1 to the other end -- so that it is "shorted" as shown below.



2. Calculate the voltage drop across each resistor and the "short". Record below. Assume exactly 10 volts are applied.

	CALCULATED	MEASURED
E_{R1}:	________ volts	________ Volts
E_{R2}:	________ volts	________ Volts
E_{R3}:	________ volts	________ Volts
E_{R4}:	________ volts	________ Volts

3. With 10 volts applied, measure the voltage across each resistor and across the "short". Record above.

4. Check your results with each RULE in the INTRODUCTION. Are they still true for this special case when there is a "short"?

Is RULE 1 true? YES/NO

Is RULE 2 true? YES/NO

Is RULE 3 true? YES/NO

Is RULE 4 true? YES/NO

Is RULE 5 true? YES/NO

Is RULE 6 true? YES/NO

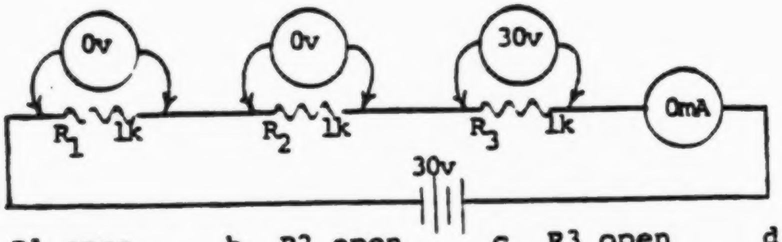
PROJECT 7: Self Evaluation Quiz

INSTRUCTIONS

To make most effective use of your time, do this quiz outside of Lab period. Go directly to the next Lab Sheet if you are prepared.

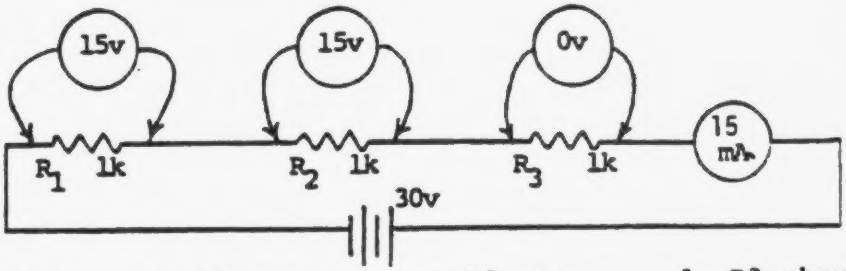
Below are schematics of circuits similar to those with which you have been experimenting. You will now do some "theoretical troubleshooting" of these circuits. Each schematic is shown in the way that the circuit should be wired. However, each circuit has one "trouble" in it which will give the meter indications shown. Your task is to observe the meter indications and decide what the "trouble" is in each circuit. Select the most correct answer from the multiple choices given. The "trouble" could be an "OPEN" or "SHORTED" component. Check your answers with the correct ones given at the end of this Lab Sheet.

1.



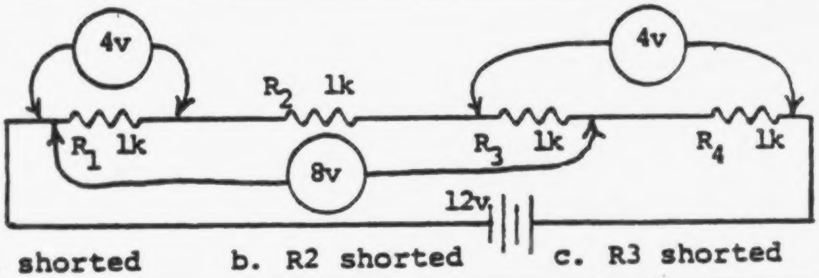
a. R1 open b. R2 open c. R3 open d. R3 shorted

2.


15v
15v
0v
R1 1k
R2 1k
R3 1k
15 mA
30v

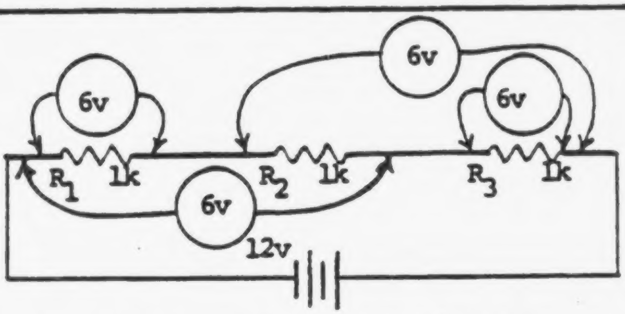
a. R1 open b. R2 open c. R3 open d. R3 shorted

3.


4v
4v
R2 1k
R1 1k
R3 1k
R4 1k
8v
12v

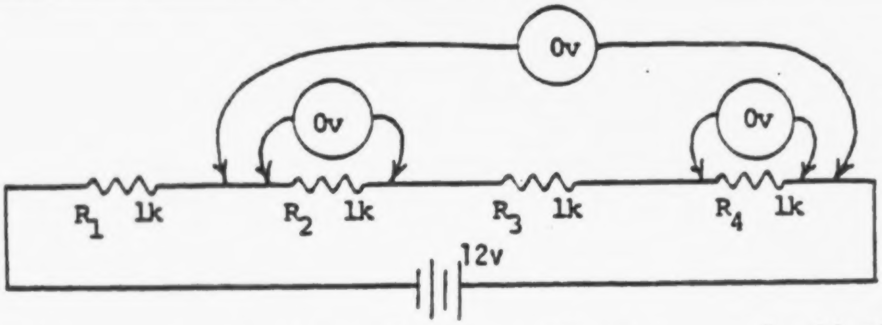
a. R1 shorted b. R2 shorted c. R3 shorted d. R4 shorted

4.


6v
6v
6v
R1 1k
R2 1k
R3 1k
6v
12v

a. R1 open b. R2 shorted c. R3 open d. R3 shorted

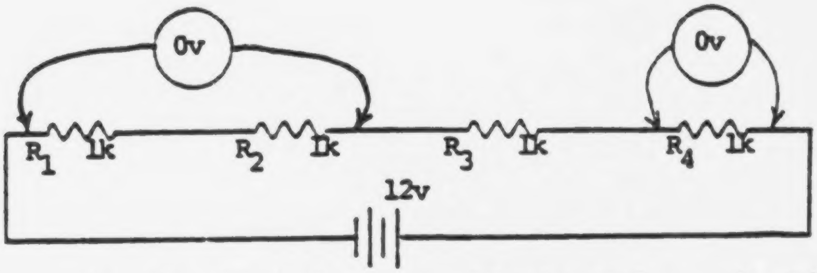
5.


0v
0v
0v
R1 1k
R2 1k
R3 1k
R4 1k
12v

a. R1 open b. R2 shorted c. R3 open d. R4 shorted

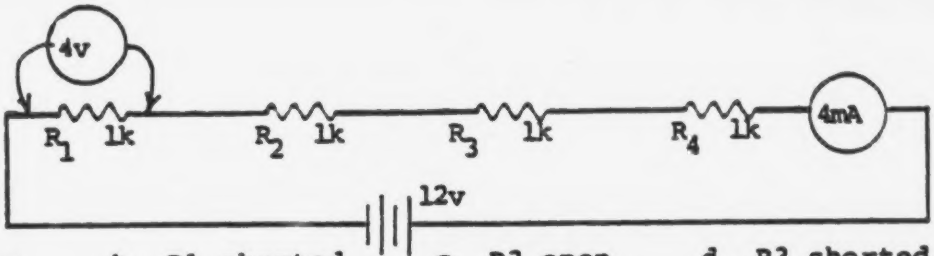
(continue to next page)

6.


0v
0v
R1 1k
R2 1k
R3 1k
R4 1k
12v

a. R3 open b. R2 shorted c. R3 shorted d. R4 open

7.

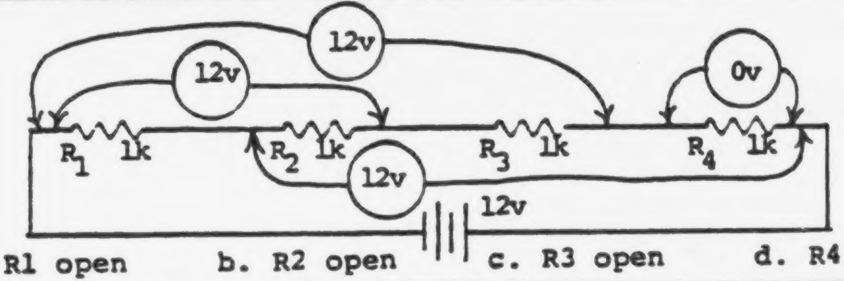

4v
R1 1k
R2 1k
R3 1k
R4 1k
4mA
12v

a. R 1 open b. R1 shorted c. R3 open d. R3 shorted.

8. In the above circuit (Q.7) the voltage across R4 will be ________V.

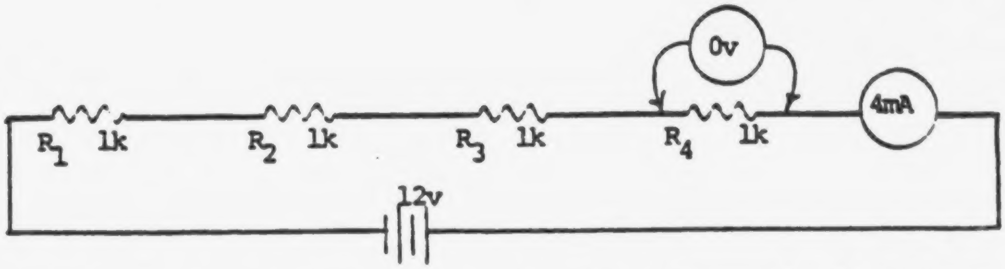
a. 0 b. 3 c. 4 d. 12

9.


12v
12v
0v
R1 1k
R2 1k
R3 1k
R4 1k
12v
12v

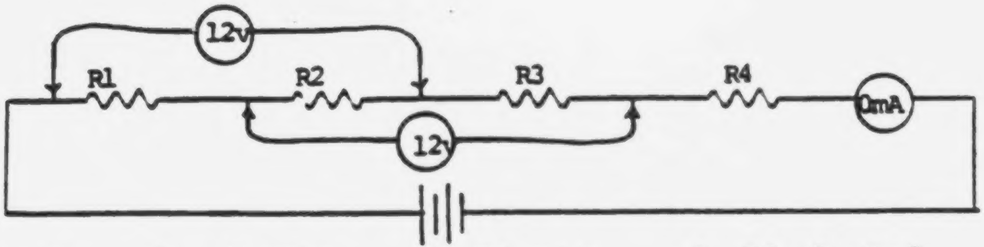
a. R1 open b. R2 open c. R3 open d. R4 shorted

10.


0v
4mA
R1 1k
R2 1k
R3 1k
R4 1k
12v

a. R3 shorted b. R3 open c. R4 shorted d. R4 open

11.

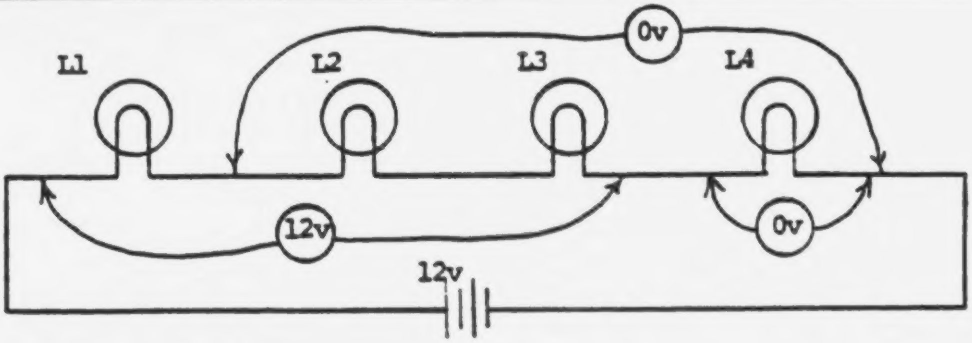

12v
R1
R2
R3
R4
0mA
12v

a. R1 open b. R2 open c. R3 open d. R4 shorted

---

12. In the question above (Q.11) the battery voltage is ________V.

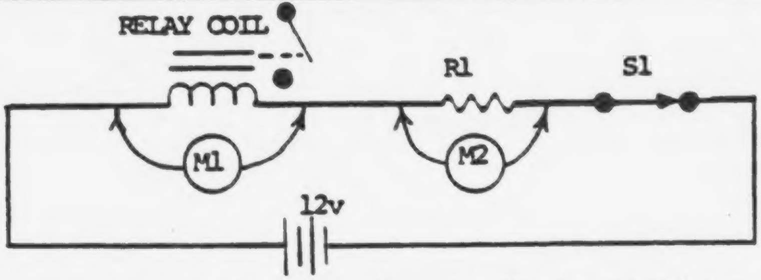
a. 12 b. 24 c. 36 d. 48


0v
L1
L2
L3
L4
12v
0v
12v

13. No lamps are lit.

a. L1 open b. L2 open c. L3 open d. L4 shorted

14.


RELAY COIL
R1
S1
M1
M2
12v

Relay does not operate when S1 closed. These readings are observed with S1 open and Closed.

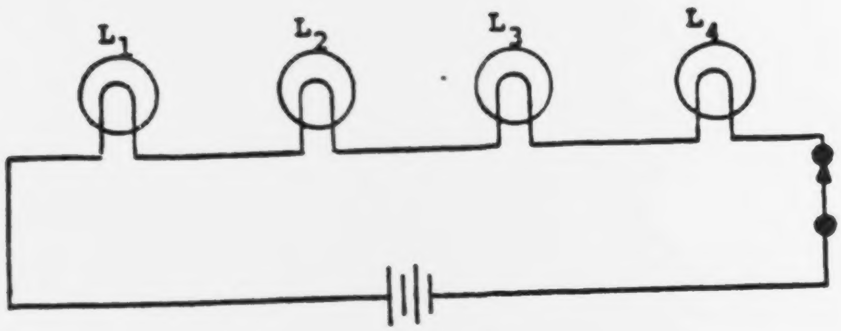
S1 open	S1 closed
M1 = 0V	M1 = 12V
M2 = 0V	M2 = 0V

The trouble could be

a. S1 open b. R1 open c. Relay coil open

d. Relay coil shorted

5.



L1, L3, and L4 are shining brightly. L2 is not lit.
The trouble could be:

a. L2 open b. L2 shorted c. L2 tired

d. L2 is a "Black light" bulb.

Answers to PROJECT 7: Self Evaluation Quiz

1. c Applied voltage appears across an open.
2. d When R = 0, I x R = E is 0 volts.
3. c Some voltage drops evident so there must be current flow. Trouble must be a short. Logic will narrow it to R3.
4. b Similar to above problem. If you got it, you are doing GREAT!
5. a No voltage drops anywhere. No current flowing. R1 must have all the applied voltage across it and it must be "Open".
6. a Similar to above problem.
7. d Milliammeter shows current and voltage drop is 4 volts. No "open". Must be a short. Checks out with right numbers if R3 shorted.
8. c 12 volts divided equally between 3 resistors = 4 volts.
9. b Applied voltage on all meters except across R4. There must not be current through R4 so an "open" must be at R2.
10. c No voltage across R4 yet current is flowing.
11. b No current flowing; applied voltage across R2.
12. a
13. a No current so must have an "open".
14. c No voltage across R1, it is all across relay and it doesn't operate.
15. b All "on" except L2. Must be shorted.

Your score: ________

How did you do? Excellent! Good Need more study

Lab Rep. # ______

Name ______________________________

Date ____________________ Per_____

SERIES CIRCUITS

Summary of Projects

Project 1 ____

____

formula ____

Project 2 ____

____

formula ____

Project 3

step 8 ____

____

formula ____

step 9 ____

____

step 10 ____

____

fromula #1 ______________ #2 ____________ #3 ____________

Project 4 ____

step 4 formula ____

step 6 formula ____

step 7 formula ____

Project 5 ____

____

formula ____

Series Circuits Summary - Projects P. 2

Project 6 ______________________________

____

formula ______________________________

Questions

How do you check for an "open" in a series circuit? ____________

____

____

How do you check for a "short" in a series circuit? ____________

____

____

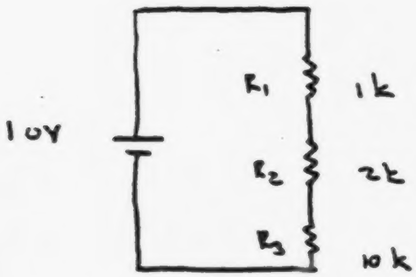
If one resistor is shorted in a series circuit? ____________

____

____

If one resistor is shorted in a series circuit the voltage on the resistors will ______________________________.

QUIZ: SERIES CIRCUITS



Solve for the following without using current

V_{R_1} = ________ = ________ = ________
formula calculations ANSWER

V_{R_2} = ________ = ________ = ________
formula calculations ANSWER

V_{R_3} = ________ = ________ = ________
formula Calculation ANSWER

Solve for the following using ohms law & series circuit laws. (show all work)

R_T = ________ = ________ = ________

I_T = ________ = ________ = ________

V_{R_1} = ________ = ________ = ________

V_{R_2} = ________ = ________ = ________

V_{R_3} = ________ = ________ = ________

Solve for the following using the power formulas.

$P_T = E^2/R$ = ________ = ________

$P_T = I_T \cdot E_T$ = ________ = ________

USE ANY FORMULA YOU WANT

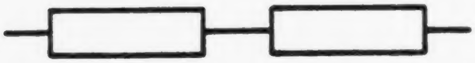
P_1 = ________ = ________ = ________
P_2 = ________ = ________ = ________
P_3 = ________ = ________ = ________
P_T = ________ = ________ = ________

Self Test

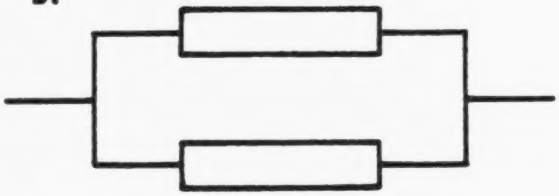
Directions Do the following problems.

1. Which of the two drawings illustrates two resistors connected in series?

A.



B.



2. A circuit is a series circuit if there

   A. are one or more current paths

   B. is just one path for current

   C. are two or more paths for current

   D. are more than two paths for current

3. A series circuit may consist of

   A. one or more resistances

   B. just one resistance

   C. two resistances

   D. two or more resistances.

4. The basic rule for current in a series circuit states that:

Self Test, con't

5. The basic rule for total voltage in a series circuit states that:

6. The mathematical expression for total resistance in a series circuit is:

7. The mathematical expression for total power in a series circuit is:

Two resistors R_1 and R_2 are connected in series across a source of emf. The power dissipated in R_1 is 16 W and the power dissipated in R_2 is 24 W. The voltage across R_1 is 8 V.
Find:

8. Resistance at R_1

9. Resistance at R_2

10. Current in the circuit.

11. Voltage drop across R_2

12. The applied voltage E_T .

13. The total power dissipated P_T.

Self Test, con't

A series circuit consists of resistances of 10, 12, and 28 Ω, respectively. The 10 Ω resistor is dissipating 90 W. Find:

14. Total voltage applied

15. Current in the circuit

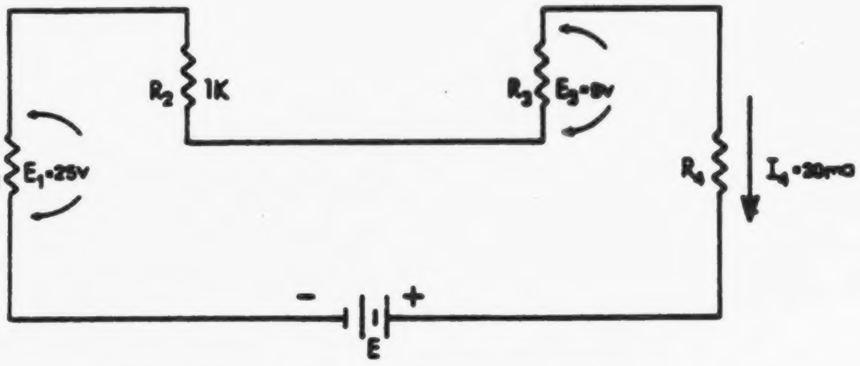
16. Voltage drop across the 12 Ω resistor

17. Voltage across the 28 Ω resistor.

18. Power dissipated by the 12 Ω resistor

19. Power dissipated by the 28 Ω resistor

Given the information shown in the following circuit schematic, find the unknown values listed.



Total circuit resistance = 3 KΩ

Self Test, con't

20. E_T = __________

21. I_T = __________

22. P_T = __________

23. R_1 = __________

24. R_3 = __________

25. E_2 = __________

26. E_4 = __________

27. I_1 = __________

28. I_2 = __________

29. I_3 = __________

30. P_1 = __________

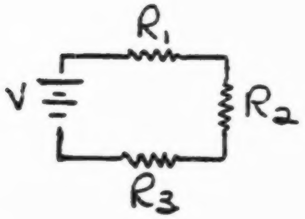
31. P_2 = __________

32. P_3 = __________

33. P_4 = __________

Electronics A
Homework Quiz

Figure A



1. Vt=110v
It=______A
Rt=______ohms
R1=48
R2=______ohms
R3=74
Vr1=_____volts
Vr2=_____volts
Vr3=54.9993volts

2. Vt=24v
It=.002A
Rt=_____ohms
R1=_____ohms
R2=3.3K ohms
R3=_____ohms
Vr1=11.2v
Vr2=____volts
Vr3=____volts

3. Vt=_____v
It=150mA
Rt=60ohms
R1=_____ohms
R2=_____ohms
R3=10 ohms
Vr1=____volts
Vr2=4.5v
Vr3=____volts

Ir1=_____A
Ir2=_____mA
Ir3=_____$x10^{-1}$

4. Vt=16.5v
It=5.5uA
Rt=_____ohms
R1=1.5Meg ohms
R2=_____Meg ohms
R3=_____K ohms
Vr1=____volts
Vr2=3.74v
Vr3=____volts
Ir1=____A
Ir2=____A
Ir3=____$x10^{-6}$

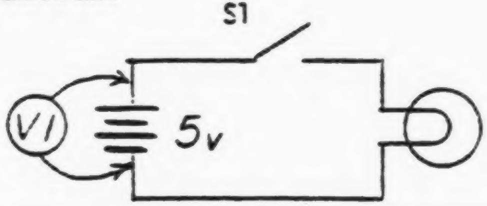
5. Vt=_____Kv
It=_____A
Rt= .5Meg ohms
R1= 120K ohms
R2=_____ohms
R3=_____Meg ohms
Vr1= .36Kv
Vr2= 780v
Vr3=____v
Ir1=____A
Ir2=____uA
Ir3=____mA

ELECTRONICS DEPARTMENT
ELECTRONICS 30

9/83/1fr

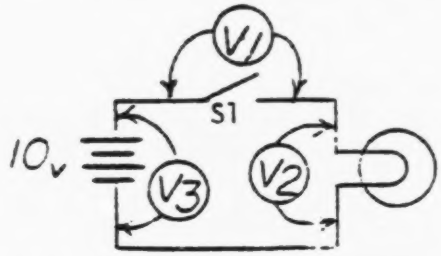
INSTRUCTIONS: Study the schematic and fill-in the value which should appear on each meter under the conditions indicated.

EXAMPLE:



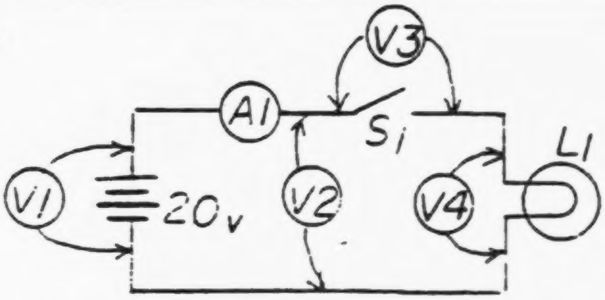
S1 OPEN	S1 CLOSED
V1 5v	V1 5v

#1



	S1 OPEN	S1 CLOSED
V1		
V2		
V3		

#2



NOTE: L1 RESISTANCE WHEN "ON" IS 40 OHMS.

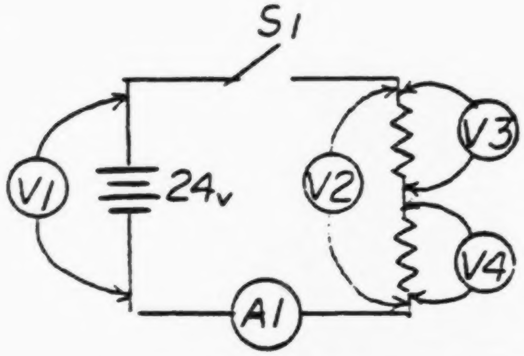
	S1 OPEN	S1 CLOSED
A1		
V1		
V2		
V3		
V4		

#3 In question #2 above if V4 reads "0"volts when S1 is closed there may be a trouble in ____.

In question #2 above if A1 reads "0" when S1 is closed there may be a trouble in ____

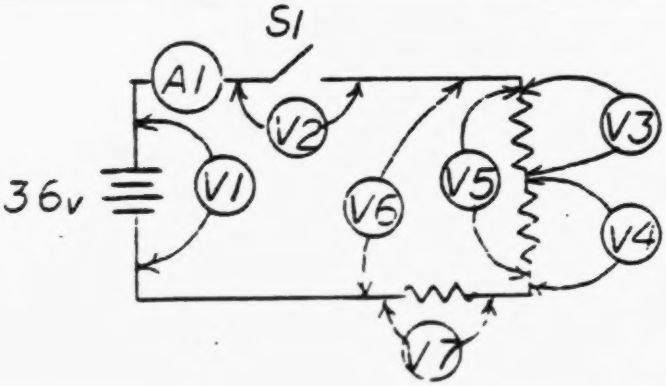
NOTE: ALL RESISTORS BELOW ARE 1000 ohms.

#4


S1
V1
24v
V2
V3
V4
A1

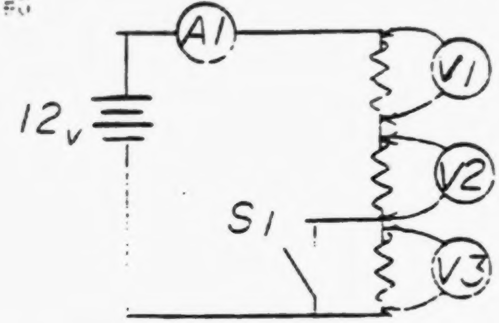
S1 OPEN	S1 CLOSED
V1 ______	V1 ______
V2 ______	V2 ______
V3 ______	V3 ______
V4 ______	V4 ______
A1 ______	A1 ______

#5


S1
A1
V2
V1
36v
V6
V5
V3
V4
V7

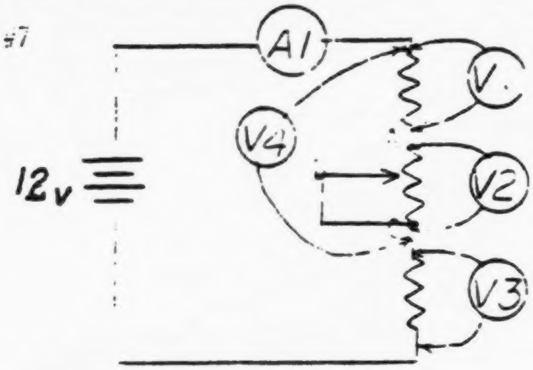
S1 OPEN	S1 CLOSED
V1 ______	V1 ______
V2 ______	V2 ______
V3 ______	V3 ______
V4 ______	V4 ______
V5 ______	V5 ______
V6 ______	V6 ______
V7 ______	V7 ______
A1 ______	A1 ______

#6


A1
12v
V1
V2
S1
V3

S1 OPEN	S1 CLOSED
A1 ______	A1 ______
V1 ______	V1 ______
V2 ______	V2 ______
V3 ______	V3 ______

#7


A1
V1
V4
12v
V2
V3

SET B TO A	SET B TO C
A1 ______	A1 ______
V1 ______	V1 ______
V2 ______	V2 ______
V3 ______	V3 ______
V4 ______	V4 ______

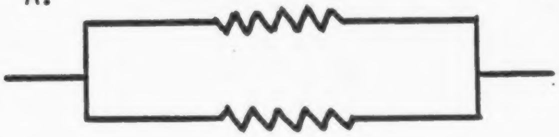
NAME________________________ GRADE______________

TEST "A" SERIES CIRCUITS

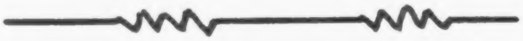
DIRECTIONS: DO THE FOLLOWING PROBLEMS.

1. Which of the drawings illustrates two resistors connected in series?

A.



B.



2. A circuit is a series circuit if there

   A. are at least two paths for current flow

   B. are more than two paths for current flow

   C. are one or more paths for current flow

   D. is just one path for current flow

3. A series circuit may consist of

   A. two or more resistances

   B. two resistances

   C. one or more resistances

   D. just one resistance

4. The basic rule for resistance in a series circuit states that

5. The basic rule for voltage in a series circuit states that

6. The mathematical expression for current in a series circuit is

Test A, Con't

7. The mathematical expression for power in a series circuit is

Two resistors R_1 and R_2 are connected in series across a source of voltage. The power dissipated in R_1 is 8 W and the power dissipated in R2 is 12 W. The voltage across R_1 is 4 V.
Find:

8. Resistance of R_1

9. Resistance of R_2

10. Current in the circuit

11. Voltage drop across R_2

12. The applied voltage E_T

13. The total power dissipated P_T

A series circuit consists of resistances of 5,6, and 14Ω, respectively. The 5Ω resistor is dissipating 45W. What is the

14. Total voltage applied

15. Current in the circuit

16. Voltage drop across the 6 resistor

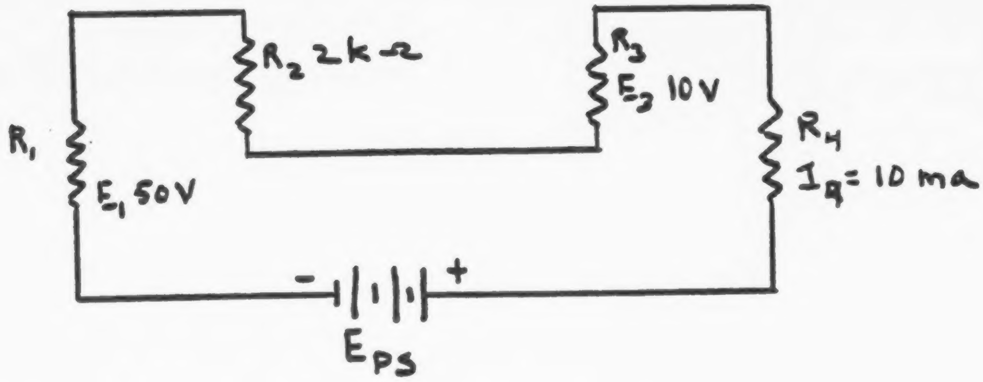
17. Voltage drop across the 14 resistor

18. Power dissipated by the 6 resistor

19. Power dissipated by the 14 resistor

Test A, con't

Given the information shown in the following circuit schematic, find the unknown values listed.


R1
E1 50V
R2 2k-Ω
R3
E3 10V
R4
I4 = 10 ma
-
+
EPS

Total circuit resistance =

20. E_T = ________

21. I_T = ________

22. P_T = ________

23. R_1 = ________

24. R_3 = ________

25. E_2 = ________

26. E_4 = ________

27. I_1 = ________

28. I_2 = ________

29. I_3 = ________

30. P_1 = ________

31. P_2 = ________

32. P_3 = ________

33. P_4 = ________

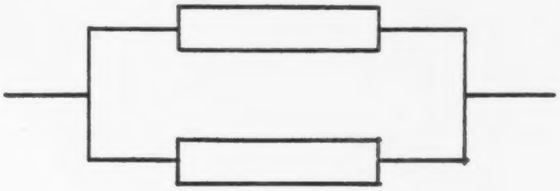
Name______________________________

Test B "SERIES CIRCUITS"

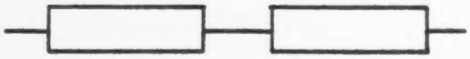
Directions Do the following problems.

1. Which of the drawings illustrates two resistors connected in series?

A



B



2. A circuit is a series circuit if there
   - A. is just one path for current flow
   - B. are one or more paths for current flow
   - C. are two paths for current flow
   - D. are more than two paths for current flow

3. A series circuit may consist of
   - A. just one resistance
   - B. one or more resistances
   - C. two resistances
   - D. two or more resistances.

4. The basic rule for resistance in a series circuit states that

5. The basic rule for current in a series circuit states that

6. The mathematical expression for voltage in a series circuit is

7. The mathematical expression for power in a series circuit is

Two resistors R_1 and R_2 are connected in series across a source of emf. The power dissipated in R_1 is 24 W. The power dissipated in R_2 is 36 W. The voltage across R_1 is 12 V.

Find:

8. Resistance of R_1

9. Resistance of R_2

10. Current in the circuit

11. Voltage drop across R_2

12. The applied voltage E_T

13. The total power dissipated P_T

Test B, cont'd

A series circuit consists of resistances of 15, 18, and 42 Ω respectively. The 15 Ω resistor is dissipating 135 W. What is the

14. total voltage applied

15. current in the circuit

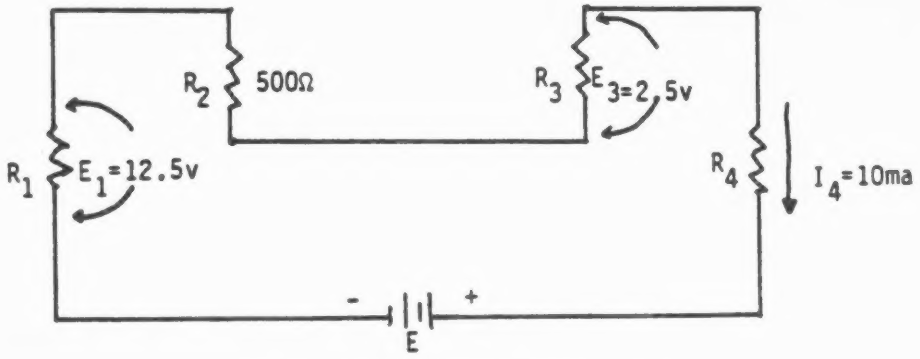
16. voltage drop across the 18 Ω resistor

17. voltage drop across the 42 Ω resistor

18. power dissipated by the 18 Ω resistor

19. power dissipated by the 42 Ω resistor

Given the information shown in the following circuit schematic, find the unknown values listed



Total circuit resistance = 3 K

20. E_T = __________
21. I_T = __________
22. P_T = __________
23. R_1 = __________
24. R_3 = __________
25. E_2 = __________
26. E_4 = __________
27. I_1 = __________
28. I_2 = __________
29. I_3 = __________
30. P_1 = __________
31. P_2 = __________
32. P_3 = __________
33. P_4 = __________

ELECTRONICS DEPARTMENT

Unit 1

Note: This exam was designed to test your ability to perform routine laboratory procedures utilized in the first five experiments of Unit I. You will be allowed to use a voltmeter (of your choice), and an ammeter. You may not use an Ohmmeter for any part of this exam.

Figure 1 represents the lay-out of the test board. Determine the color-coded values and % tolerances for the resistors specified in questions 1 thru 3.

1. Resistor #4:
   a) 560 ± 5%   b) 6500 ± 10%   c) 5600 ± 10%   d) 650 ± 10%

2. Resistor #5:
   a) 10 M ± 10%   b) 1 M ± 5%   c) 100K ± 10%   d) 1 K ± 5%

3. Resistor #6:
   a) 3 K ± 5%   b) 3 K ± 10%   c) 300 ± 10%   d) 300 ± 5%

Questions 4 thru 8 refer to the schematic in Figure 2.
Construct the circuit in Figure 2 using the unknown resistor #1 (from your test board), in series with the 3.3K resistor from your AC/DC board.

4. I_T measures ________ mA.
   a) 5   b) 1.8   c) .2   d) 10

5. The voltage across R#1 measures ________ V.
   a) .5   b) 2   c) 8   d) 4.2

6. The resistance of R#1 must be ________.
   a) 10K   b) 2.3K   c) 5K   d) 230

7. The calculated power dissipated across R#1 is ________ mW.
   a) 7.6   b) 18   c) .2   d) 15

8. The calculated power dissipated across the 3.3K is ________ mW.
   a) 10.1   b) 1.8   c) 15   d) .1

9. The total calculated power dissipated by the circuit is ________ mW.
   a) 100   b) 18   c) 180   d) .5

Figure 1

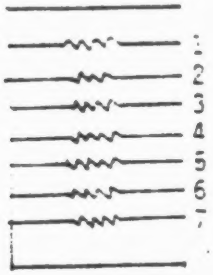
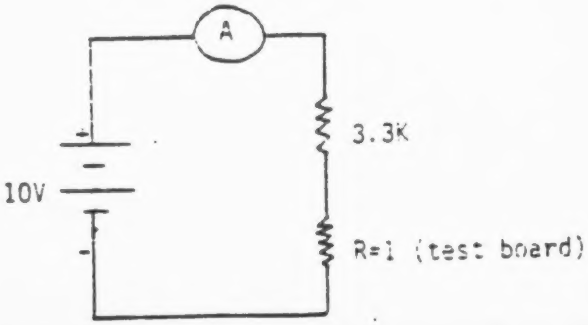


Figure 2



The remaining questions deal with a circuit to be designed and constructed.

Design a series circuit consisting of two resistors, designated A and B, which meets the following circuit requirements: (Note: use scratch paper for your schematic).

P_T = 14.4 mW I_T = 1.6 mA P_T = Total power consumed by the circuit.

P_A = 2.5 mW P_A = Power dissipated by resistor A.

10. From the information given, E_{APP} must be ________V.
a) 5   b) 9   c) 15   d) 20

11. The power dissipated by resistor B must be ________mW.
a) 15   b) 11.9   c) 1.2   d) 2.5

12. The voltage across resistor A is ________V.
a) 5   b) 7   c) .5   d) 1.6

13. The voltage across resistor B is ________V.
a) 7.4   b) 2   c) 5   d) .5

14. The resistance of A must, therefore, be ________K ohms.
a) .1   b) 1   c) 5   d) 10

15. The resistance of B must, therefore, be ________K ohms.
a) 10   b) 6.8   c) 4.7   d) 1

Construct the circuit and verify your calculations.

GLOSSARY

ELECTRONICS

TECHNICAL VOCABULARY

SERIES RESISTIVE CIRCUITS

parallel circuits
series circuits
combined total resistance

GLOSSARY

ELECTRONICS

RELATED GENERAL VOCABULARY

SERIES RESISTIVE CIRCUITS

pertaining to
cross-checking
various points
as follows
reading assignment
contributes
governing
extremely
valid
is consistent with
make most effective use of
illustrates

series

CONTAINING :	chứa, đựng
path :	con đường (chỉ mạch điện)
commonly :	thông thường, chung.
distribute :	phân phối, phân phát
Throughout :	khắp nơi; suốt.
utilize :	dùng; lợi dụng
miniature :	tranh vẽ thu nhỏ
rule :	qui tắc
Formule :	công thức
pertain :	liên quan; quan hệ tới.
sufficient :	đầy đủ
Solution (n):	giải pháp, giải quyết
Ohm's Law :	định luật OHM
Watt's Law :	định luật Watt
Objective :	mục đích
Directions :	phương hướng (làm việc)
end-to end :	tận cùng này đến tận cùng khác (nối tiếp nhau)
the same as :	giống nhau; cùng.
Total Voltage :	tổng số điện thế.
equal To :	bằng với.
the sum of :	tổng số.
Voltage drop :	điện thế được phân phối tại các điện trở.
individual :	riêng biệt; cá nhân.
makeing up :	tạo nên; làm nên.
composed :	được tạo thành.
analyzing :	phân tách
solve :	giải quyết
problem :	bài toán; vấn đề
horizontal :	ngang
line :	đường
Vertical :	dọc
Colume :	cột (trụ), hàng
Examination :	sự khảo sát.
reveal :	cho biết.
several :	nhiều (6, 7)
method :	phương pháp.
power dissipated :	công suất tiêu thụ.
without :	bên ngoài, ở ngoài.
con't (continue) :	tiếp tục

verified :	được thử lại
verification :	sự thử lại
various (adj)	đổi khác
adjust :	điều hoà
toward :	hướng về
probe :	que thử (lead)
prove :	chứng minh
compare :	so sánh
previously :	ở trước, phía trước.
Negative probe:	que âm (thử)
positive probe:	que dương (thử)
insert :	đặt xen vào.
drawings illustrates :	tranh vẽ sơ lược (số nhiều)
just one path :	chỉ một mạch điện (con đường)
consist :	gồm có
states that :	phát biểu rằng:
Self test :	Tự khảo sát
source :	nguồn điện
respectively :	theo thứ tự
shown :	chỉ (một vấn đề)
listed :	liệt kê (vào danh sách); ghi ra

ghi chú:
- ở mạch nối tiếp (series circuit) khi đo điện trở chúng ta đo từng điện trở một không cần phân biệt dấu (-) hay dương. Nhưng, mạch điện lúc nào cũng tách ra khỏi điện thế.
- khi đo cường độ của mạch series máy đo (milliammeter ký hiệu -(mA)-) phải đặt nối tiếp vào mạch điện có nghĩa là ngắt mạch điện tại một điểm rồi đặt máy đo xen vào âm theo (-); dương theo (+). Trị số cường độ của mạch nối tiếp đều bằng nhau và bằng cường độ của nguồn điện.

串联电阻电路 (SERIES RESISTIVE CIRCUIT:

containing : 包含.

distribute : 分配

different : 不同的.

throughout : …之中、整個…

system : 系統

utilize : 利用, 耗用.

hi-fi speaker : 高頻率揚声器

miniature : 小型的, 模型

pertain : 属於 , 関於…,

sufficient : 足夠的.

Known value : 已知數值.

in the package : 在本章節.

solve : 解決.

voltage drop : 电压降.

equal : 等於

sum : 和

individual : 各別的, 單個的.

making up : 建成, 組成

compose : 組成. 構圖.

two step process : 兩個步驟方式

determined : 决定.

analyzing : 分析. 解析.

vertical column : 垂直欄.

horizontal line : 水平欄.

reveal : 顯露. 顯示.

chart : 表格.

remaining : 剩餘的.

cross-checking : 交替檢查.

inserting : 插入.

ELECTRONIC CURRICULUM
VOCATIONAL TRAINING LESSON PLAN # V

Parallel Resistive Circuits

Teaching Materials Source ____________________

Chapter __________, **pages** __________

Lab Manual pages __________

Additional Instructor Materials ____________________

Main concepts student will learn:

The student will be able to:

1. identify parallel circuits in a diagram and list an example of practical uses for each type of circuit arrangement.
2. solve for total resistance utilizing proper formulas and units of measurement for each type of circuit arrangement.
3. verify calculated values of voltage, current, and resistance for a parallel circuit by assembling a test circuit and measuring quantities with the proper meter.
4. recite and apply both Ohm's and Kirchhoff's Laws as requested when solving or evaluating parallel circuits.

Technical Vocabulary

parallel circuit
conductance
reciprocal

Related General Vocabulary

Teaching Activity

Same as for series circuits.

Materials and Notes

Length of Lesson

1 week

Evaluation

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of oral or written testing procedures.

EL-BC-08 Parallel Resistive Circuits

INDIVIDUALIZED LEARNING SYSTEMS

Electronics

EL-BC-08

PARALLEL RESISTIVE CIRCUITS

BASIC CONCEPTS

The parallel circuit has more than one path for current to flow as do most practical circuits in electrical work. The lighting system in your home, adding speakers to amplifiers, connecting a light organ to your radio, are examples of parallel circuits.

OBJECTIVE

1. From a given list you will be able to select two basic characteristics of a parallel circuit.

2. You will be able to state the relationship between the applied voltage and the voltage across the individual branches in a parallel circuit.

3. You will be able to compute the individual branch current and total current in a parallel circuit.

4. Given any number of parallel resistances you will be able to correctly calculate the equivalent (total) conductance and resistance of the parallel circuit.

5. Given any number of parallel resistances you will be able to compute power dissipation in parallel circuits.

Directions

Do the following.

Learning Opportunities	Reasons
1. Look up and study key index words for basic information.	1. Explains parallel circuit relationships.
2. Do Experiment #1	2. Proves voltage relationships.
3. Do Experiment #2	3. Verifies current relationships.
4. Do Experiment #3	4. Verifies resistance relationships
5. Read Information Summary.	5. Tells what this package is all about.

Key Index Words

parallel circuit

conductance

reciprocal

INFORMATION SUMMARY

1. Voltage across all branches of a parallel circuit are equal.

   $E_t = E_1 = E_2 = E_3$

2. Current into and out of a parallel circuit is equal to the sum of the branch currents.

   $I_t = I_1 + I_2 + I_3$

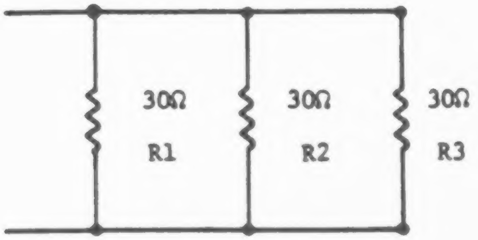
3. Total resistance in any parallel circuit must be less than the value of the smallest resistor in the parallel circuit.

4. There are several methods used to determine the equivalent resistance of parallel circuits. The most appropriate method depends on the number and value of the resistors. The total resistance of resistors in parallel is often referred to as equivalent resistance or total resistance.

   Finding R_t (total resistance) when EQUAL RESISTORS are connected in parallel:

   $$R_t = \frac{R}{N} \quad \begin{matrix}\text{value of one resistor} \\ \text{number of resistors in network}\end{matrix}$$

   Example:



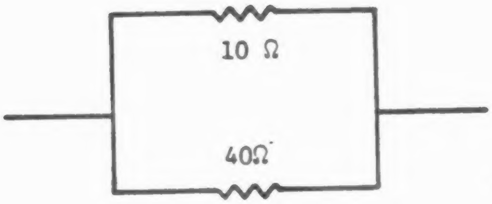
$$R_t = \frac{R}{N}$$

$$R_t = \frac{30}{3} = R_t = 10\Omega$$

When ONLY TWO UNEQUAL RESISTORS are connected in parallel, the following formula is convenient to use:

$$R_T = \frac{R_1 \times R_2}{R_1 + R_2}$$

Example:



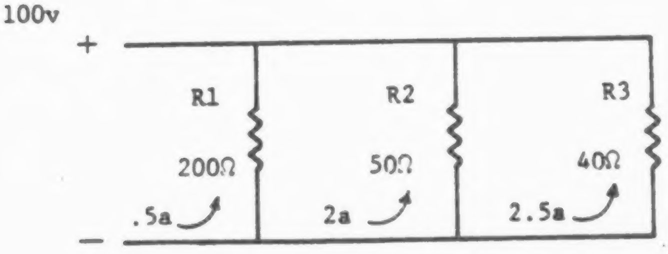
$$R_t = \frac{(10)(40)}{10 + 40} = \frac{400}{50} = 8\Omega$$

$$R_t = 8$$

When THREE OR MORE UNEQUAL RESISTORS are connected in parallel, you may choose one of the following methods:

A. Ohm's Law or Total current method

Example:



E_t applied voltage assumed 100v

$I_t = I_1 + I_2 + I_3$

$.5a + 2a + 2.5a = 5a \qquad R_t \ \frac{100v}{5a} = 20\Omega \quad R_t = 20\Omega$

B. Reciprocal Method

The following formula is called " the reciprocal of the sum of the reciprocals" and is the one normally used to solve for the equivalent resistance.

$$R_{eq} = \frac{1}{\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}}$$

This method is very convenient to use with the CI scale on your slide rule.

C. Conductance Method

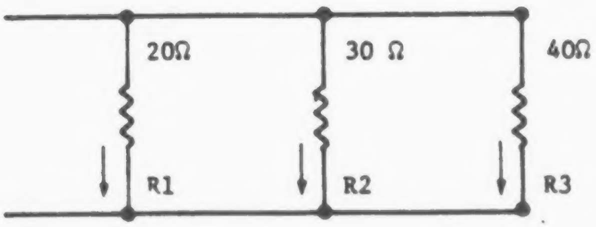
The degree to which a circuit conducts current is called the conductance (G) of the circuit. The unit of conductance (G) is called a mho, which is ohms spelled backwards.

$$G = \frac{1}{R} \qquad \text{or} \qquad R = \frac{1}{G}$$

In a parallel circuit the total conductance is equal to the sum of the individual branch conductances.

$$G_t = G_1 + G_2 + G_3$$

Example:



$$G_1 = \frac{1}{R1} = \frac{1}{20} = .05 \text{ mho}$$

$$G_2 = \frac{1}{R2} = \frac{1}{30} = .033 \text{ mho}$$

$$G_3 = \frac{1}{R3} = \frac{1}{40} = .025 \text{ mho}$$

5. The sum of the individual values of power dissipated in the resistances equal the total power produced by the source.

$$P_t = P_1 + P_2 + P_3 \ldots\ldots\ldots\ldots P_n$$

Name: ____________

SCORE:

GRADE:

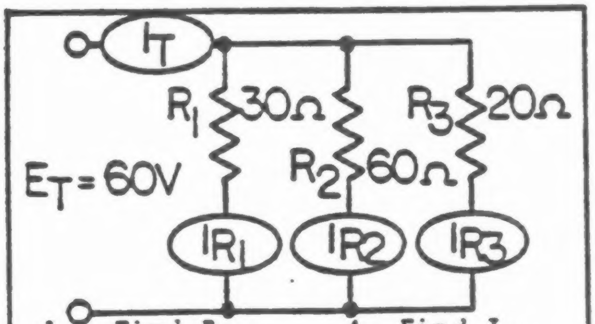
Date: ____________

Period: ____________

WORKSHEET

PARALLEL CIRCUIT ANALYSIS #2

Solve the following circuit problems. Be certain to show work, and record your answer in the answer box.

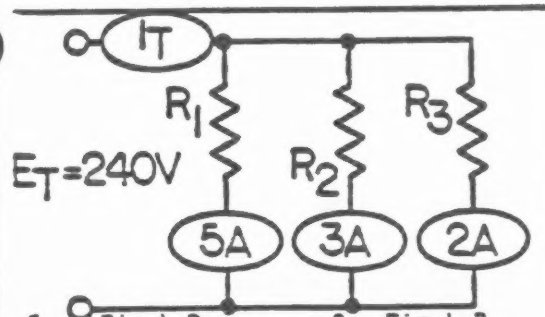


I_T
R_1 30Ω
R_2 60Ω
R_3 20Ω
$E_T = 60V$
IR_1
IR_2
IR_3

1. Find R_T
2. Find I_T
3. Find I_{R_1}
4. Find I_{R_2}
5. Find I_{R_3}

Show work

1. ____________
2. ____________
3. ____________
4. ____________
5. ____________

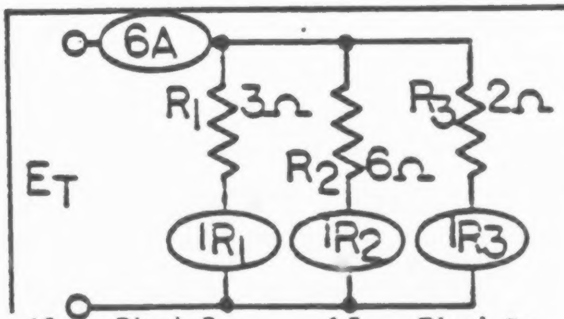


I_T
R_1
R_2
R_3
$E_T = 240V$
5A
3A
2A

6. Find R_1
7. Find R_2
8. Find R_3
9. Find I_T

Show work

6. ____________
7. ____________
8. ____________
9. ____________



6A
R_1 3Ω
R_2 6Ω
R_3 2Ω
E_T
IR_1
IR_2
IR_3

10. Find R_T
11. Find E_T
12. Find I_{R_1}
13. Find I_{R_2}
14. Find I_{R_3}

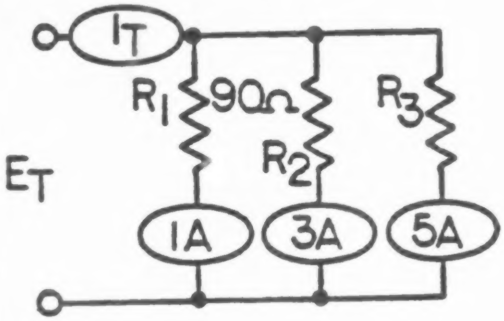
Show work

10. ____________
11. ____________
12. ____________
13. ____________
14. ____________

Name: ______________________

Date: ______________________

Period: ______________________


I_T
R_1
90Ω
R_2
R_3
E_T
1A
3A
5A

18. Find I_T
19. Find E_{R_1}
20. Find E_T
21. Find R_2
22. Find R_3
23. Find R_T

Show work

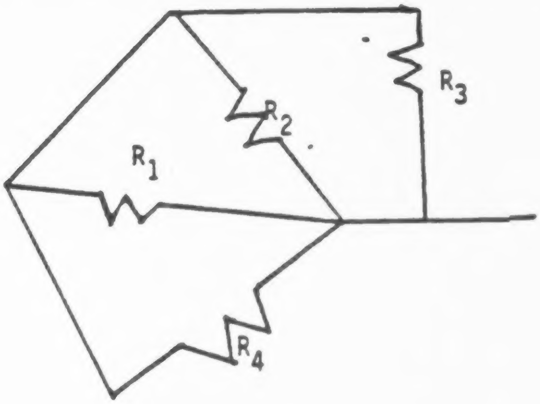
18. ☐
19. ☐
20. ☐
21. ☐
22. ☐
23. ☐

Problem Sheet #__________

Name________________________

Date___________ Per.______

Parallel Circuits



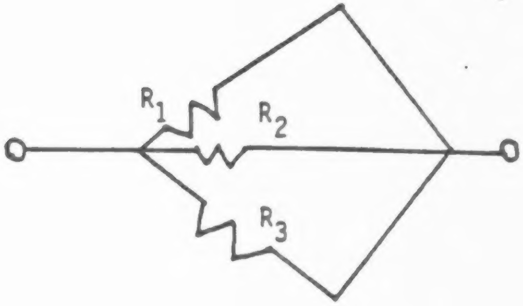
R_1=10 Ω

R_2=50 Ω

R_3=20 Ω

R_4=70 Ω

Rt=________________________



E_T=240V

I_1=5A

I_2=3A

I_3=2A

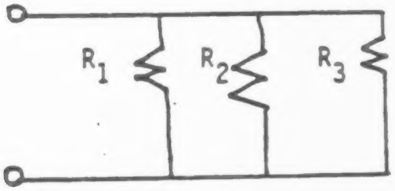
R_1__________

R_2__________

R_3__________

It__________

PT__________



R_t=5 Ω

R_3=10 Ω

I_1=2A

IT=12A

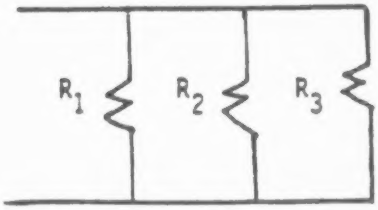
Et__________

R_1__________

I_3__________

R_2__________

PT__________



I_t=6A

I_1=3A

R_1=100 Ω

R_2=150 Ω

ET__________

I_2__________

I_3__________

R_3__________

RT__________

P_1__________

P_2__________

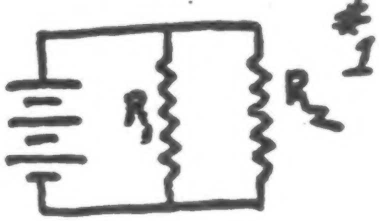
P_3__________

PT__________

PARAllel Problem
sheet #2

PARAllel CIRCUITS

FIG #1

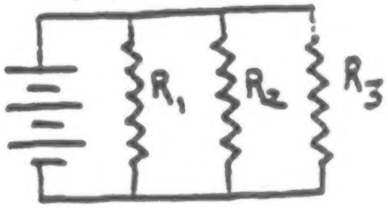


#1
$V = 100V$
$R_1 = 50\Omega$
$R_2 = 40\Omega$
R_T = ____
P_{R_1} = ____
P_{R_2} = ____
P_T = ____
I_T = ____
I_{R_1} = ____
I_{R_2} = ____

#2-FIG 1
$V = 150V$
$R_1 = 30\Omega$
R_2 = ____
R_T = ____
P_{R_1} = ____
P_{R_2} = ____
P_T = ____
$I_T = 12A$
I_{R_1} = ____
I_{R_2} = ____

#3·FIG 1.
V = ____
$R_1 = 100K\Omega$
R_2 = ____
R_T = ____
P_{R_1} = ____
P_{R_2} = .4545 mW
P_T = ____
I_T = ____
I_{R_1} = ____
I_{R_2} = 45.45 MA

FIG #2



#1
$V = 10V$
$R_1 = 25\Omega$
$R_2 = 50\Omega$
R_3 = ____
$R_T = 14.285\Omega$
P_{R_1} = ____
P_{R_2} = ____
P_{R_3} = ____
P_T = ____
I_T = ____
I_{R_1} = ____
I_{R_2} = ____
I_{R_3} = ____

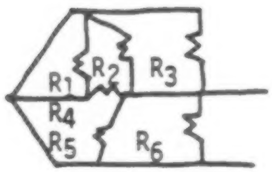
#2-FIG #2
$V = 200V$
$R_1 = 50\Omega$
R_2 = ____
$R_3 = 100\Omega$
R_T = ____
P_{R_1} = ____
P_0 =
$I_T = 12A$
I_{R_1} = ____
I_{R_2} = ____
I_{R_3} = ____

#3-FIG-2
V_1 = ____
$R_1 = 5K\Omega$
R_2 = ____
$R_3 = 10K\Omega$
P_T = ____
$P_{R_1} = 29.03W$
$P_{R_2} = 241.935\ w$
I_T = ____
I_{R_1} = ____
I_{R_2} = ____
I_{R_3} = ____

Name____________________________

PROBLEM SHEET #______________ Date__________ Per.__________

Parallel Circuits



R_1=560 Ω

R_2=1K Ω

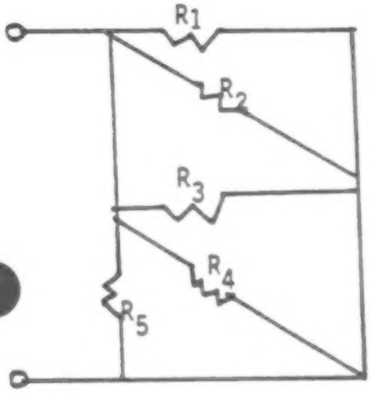
R_3=150 Ω

R_4=1200 Ω

R_5=470 Ω

R_6=3.3K Ω

Rt=____________________



R_1= 1.2K	P_1= 3W	I_1=______	E=______
R_2=______	P_2=______	I_2= 12mA	
R_3=______	P_3= 12W	I_3=______	
R_4= 6K	P_4=______	I_4=______	
R_5=______	P_5=______	I_5= .0002A	
Rt=______	Pt=______	I_6=______	

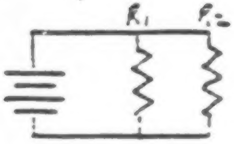
3. What is the law about voltage in a parallel circuit?

4. What is the mathematical formula for voltage in a parallel cicuit?

5. What is the law about current in a parallel circuit?

6. Math formula for current in a parallel cicuit?

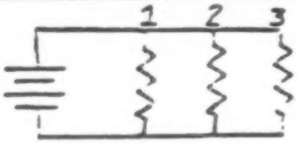
PARALLEL CIRCUITS



$V = 10$ VDC
$R_1 = 30\Omega$
$R_2 = 40\Omega$

I_{R1} = ______
I_{R2} = ______
I_T = ______
R_T = ______

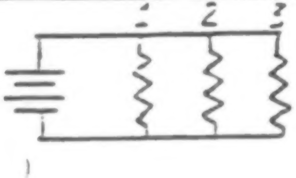
P_{R1} = ______
P_{R2} = ______
P_T = ______



$V = 10$ VDC
$R_1 = 1.2K\Omega$
$R_2 = 3.3K\Omega$
$R_3 = 4.7K\Omega$

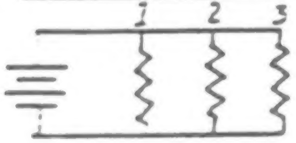
I_{R1} = ______
I_{R2} = ______
I_{R3} = ______
I_T = ______
R_T = ______

P_{R1} = ______
P_{R2} = ______
P_{R3} = ______
PT = ______



$V = 1$ VDC
$R_1 = 3.6K\Omega$
$R_2 = 43K\Omega$
$R_3 = 4.7K\Omega$

I_{R1} = ______
I_{R2} = ______
I_{R3} = ______
I_T = ______
R_T = ______



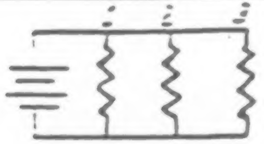
$R_1 = 3.6K\Omega$
$R_2 = 43K\Omega$
$R_3 = 4.7K\Omega$

$G = 1/R$

$R = 1/G$

G_1 = ______
G_2 = ______
G_3 = ______
R_T = ______

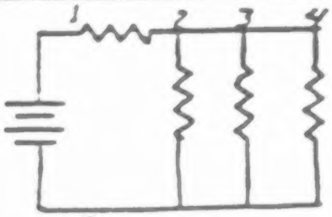
$I = G \times V$

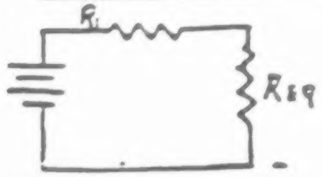


$V = 12$ VDC
$R_1 = 1.8K$
$R_2 = 2.2K$
$R_3 = 2.7K$

G_1 = ______
G_2 = ______
G_3 = ______
G_T = ______
R_T = ______

I_1 = ______
I_2 = ______
I_3 = ______
I_T = ______





$V = 12$ VDC
$R_1 = 1.8K$
$R_2 = 2.2K$
$R_3 = 2.7K$
$R_4 = 3.3K$

G_2 = ______
G_3 = ______
G_4 = ______
G_T = ______

$R_{EQ} = \frac{1}{G_T}$ = ______

$R_T = R_1 + R_{EQ}$ = ______

$I_T = I_1$ = ______
V_{R1} = ______
V_{REQ} = ______
V_2 = ______
V_3 = ______
V_4 = ______

AMERICAN RIVER COLLEGE
ELECTRONICS DEPARTMENT

9/85/lfr

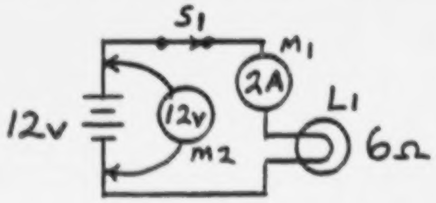
Electronics 30

METER PRACTICE

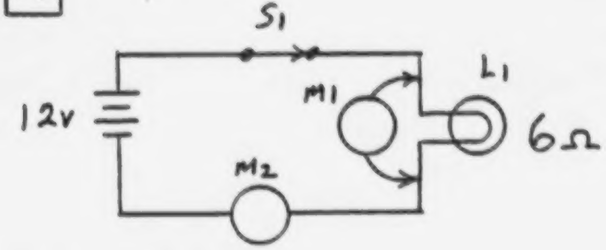
INSTRUCTIONS

Below are shown schematics of simple circuits. In each circuit are one or more meters of an unidentified type. Each meter is represented by a circle. You must identify if each meter is a voltmeter or ammeter by the way it is connected in the circuit. Then write in the circle the value which this meter should be indicating. Assume that all switches are closed(ON) unless indicated otherwise.

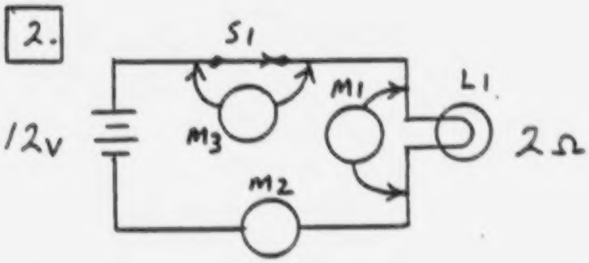
EXAMPLE


S1
M1
2A
L1
12v
12v
M2
6Ω

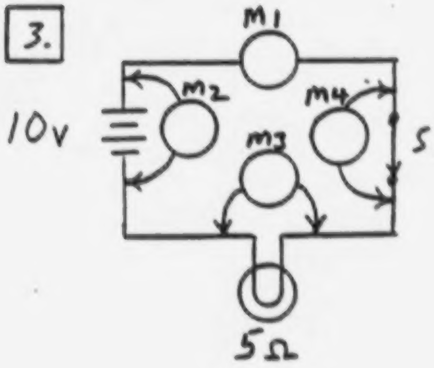
1.


S1
L1
12v
M1
6Ω
M2

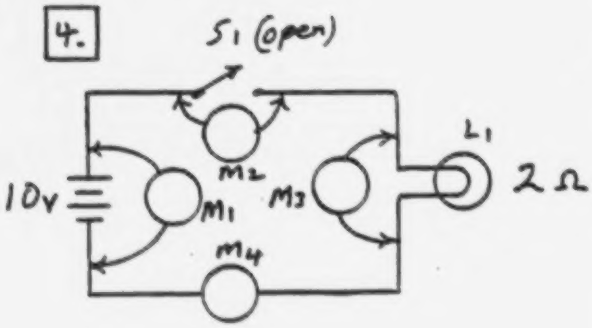
2.


S1
M1
L1
12v
M3
2Ω
M2

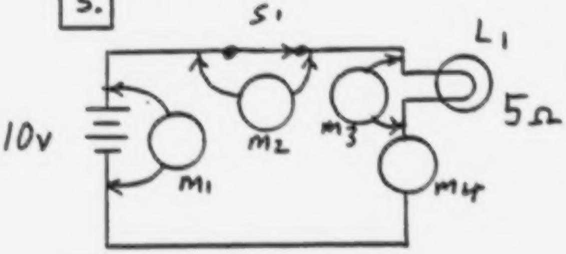
3.


M1
10v
M2
M4
M3
S1
5Ω

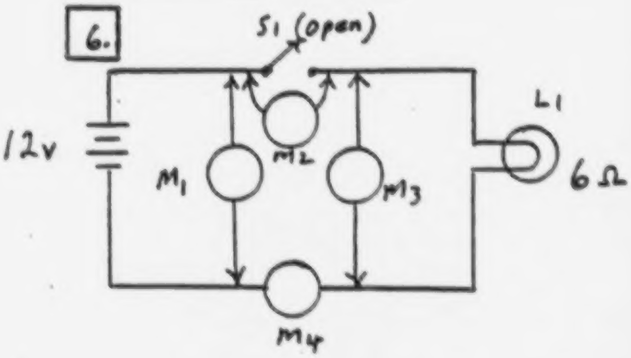
4.


S1 (open)
L1
M2
10v
M1
M3
2Ω
M4

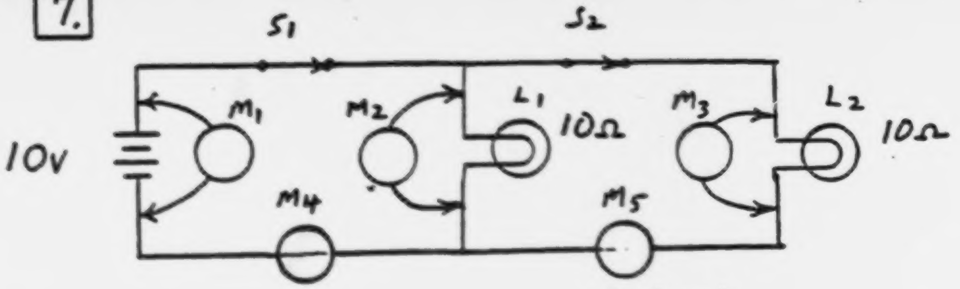
5.


S1
L1
10v
M2
M3
5Ω
M1
M4

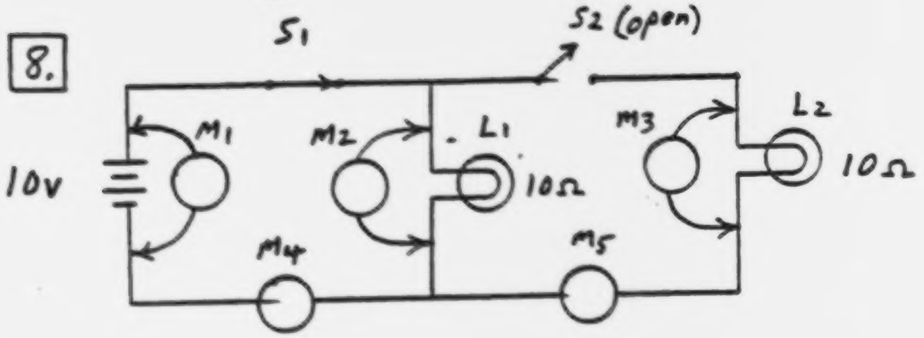
6.


S1 (open)
L1
12v
M1
M2
M3
6Ω
M4

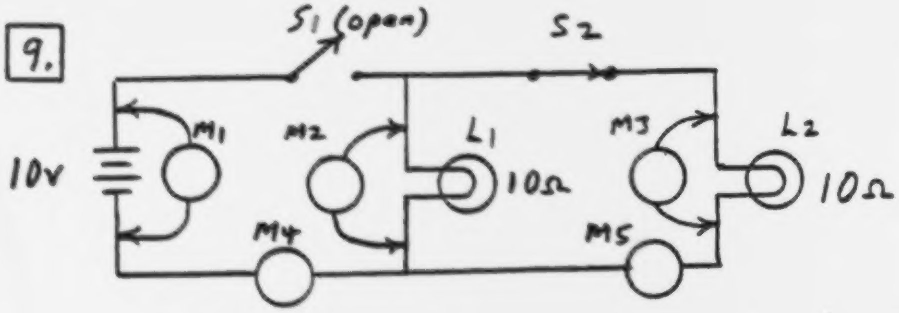
7.


S1
S2
10v
M1
M2
L1
10Ω
M3
L2
10Ω
M4
M5

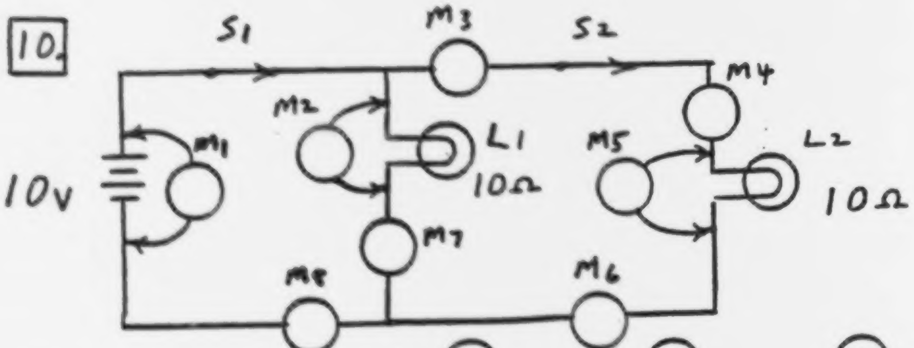
8.


S1
S2 (open)
10v
M1
M2
L1
10Ω
M3
L2
10Ω
M4
M5

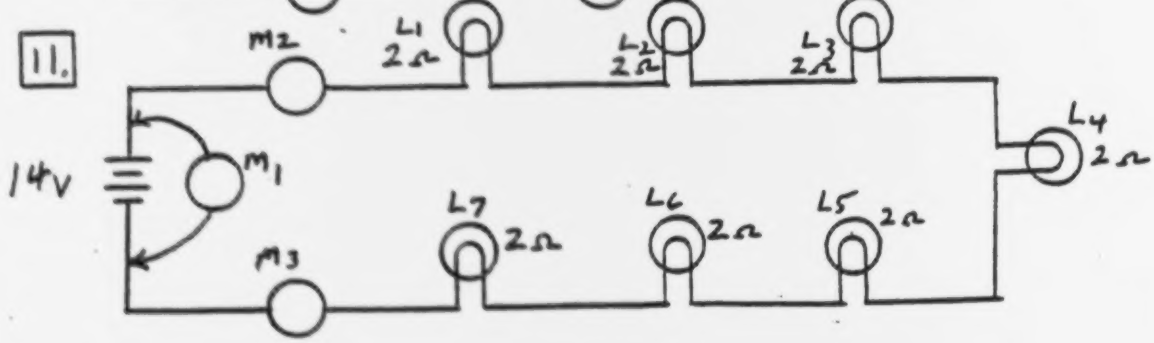
9.


S1 (open)
S2
10v
M1
M2
L1
10Ω
M3
L2
10Ω
M4
M5

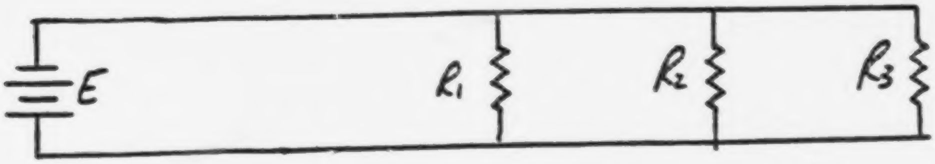
10.


S1
M3
S2
M4
M2
L1
10Ω
M1
10v
M5
L2
10Ω
M7
M8
M6

11.


M2
L1
2Ω
L2
2Ω
L3
2Ω
L4
2Ω
14v
M1
M3
L7
2Ω
L6
2Ω
L5
2Ω

NAME________________



E_T=15 VOLTS I_1=10mA I_2=75mA R_3=1.8K

FIND:

E_1__________

E_2__________

E_3__________

I_3__________

I_T----__________

R_1__________

R_2__________

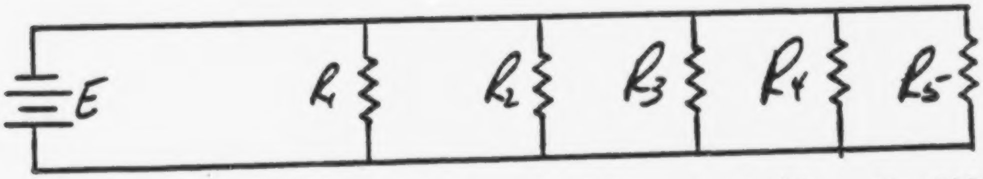
R_T__________

P_1__________

P_2__________

P_3__________

P_T__________


E
R1
R2
R3
R4
R5

I_1=2mA I_2=0.005 A R_1=1K R_3=1.8K R_5=3000 P_4=.03W

FIND:

E_1__________

E_2__________

E_3__________

E_4__________

E_5__________

E_T__________

I_1__________

I_4__________

I_5__________

I_T__________

R_2__________

R_4__________

R_T__________

P_1__________

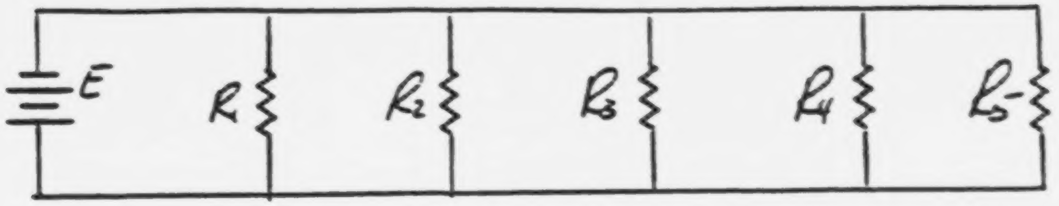
P_2__________

P_3__________

P_5__________

P_T__________

NAME________________ DATE________


E
R
R2
R3
R4
R5

$R_1 = 10\,\Omega$

$R_2 = 20\,\Omega$

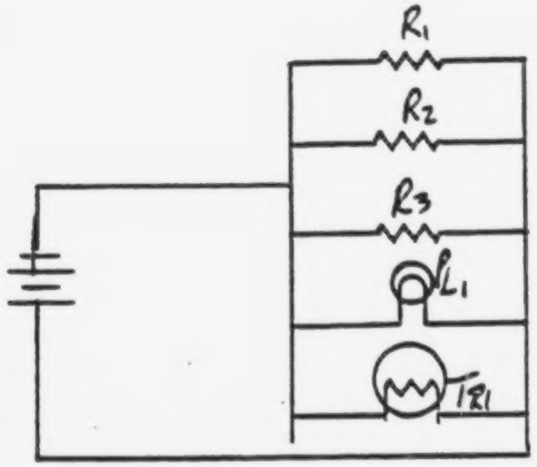
$R_3 = 15\,\Omega$

$R_4 = 25\,\Omega$

$R_5 = 5\,\Omega$

$I_T = 20\,mA.$

FIND E, I, P.


R1
R2
R3
PL1
TR1

$R_1 = 10\,\Omega$

$P_2 = 3W$

$R_3 = 25\,\Omega$

$I_{PL1} = .2A$

$P_{PL1} = .05W$

$I_{TR1} = .05A$

EXPERIMENT

Experiment #1

Voltage in Parallel Circuits

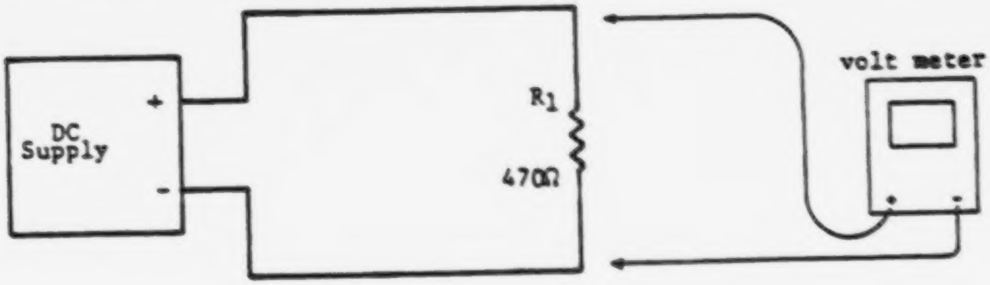
MATERIALS: (resistor values are approximate)

270Ω ¼w
470Ω ¼w
1000Ω ¼w

Low voltage power supply
VTVM

PROCEDURES:

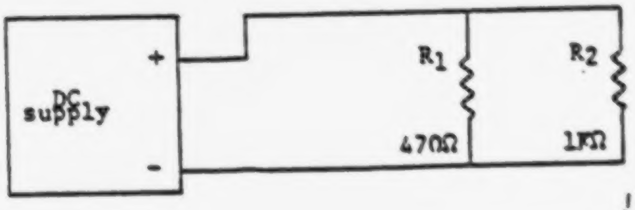
1. Connect circuit as shown below:


+
DC Supply
-
R1
470Ω
volt meter
+
-

2. Adjust DC power supply to 15V.

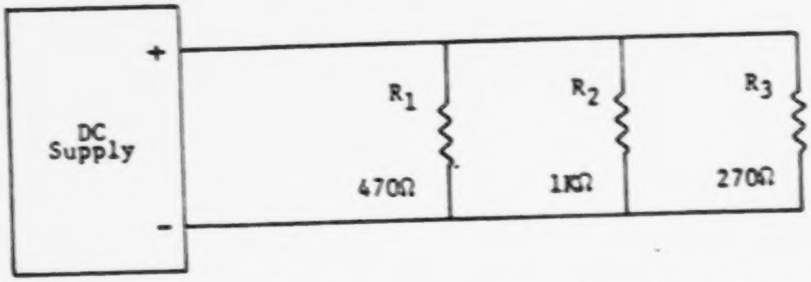
3. Using a voltmeter measure the voltage across R_1. Record_______________

4. Connect circuit as shown below:


+
DC supply
-
R1
470Ω
R2
1KΩ

5. Measure voltage across R_1 and R_2. Record____________________

6. Connect circuit as shown:


+
DC Supply
-
R_1
470Ω
R_2
1KΩ
R_3
270Ω

7. Measure voltage across R_1, R_2, and R_3. Record ____________________

____

____

8. Do the results of these measurements verify that voltage remains the same across each resistor?

9. Write the equation which verifies the results of this experiment.

Experiment #2

Current in Parallel

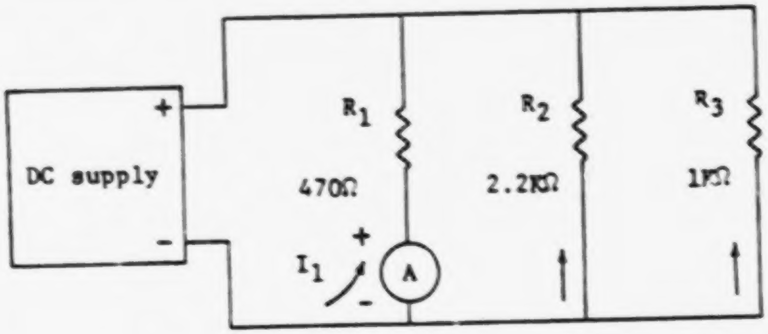
MATERIALS - EQUIPMENT (resistor values are approximate)

Ammeter 0-100 ma
VTVM
Low voltage power supply

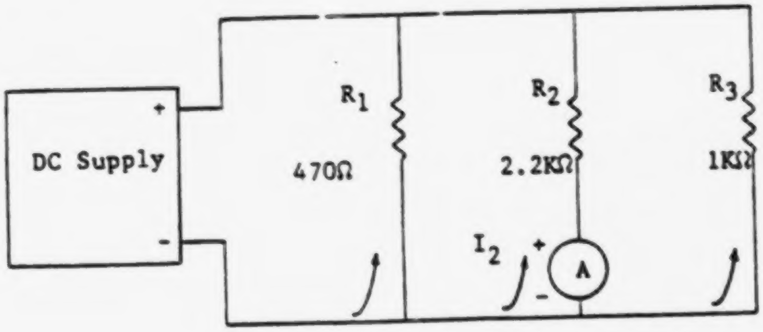
2.2KΩ ¼w
1KΩ ¼w
470Ω ¼w

PROCEDURE:

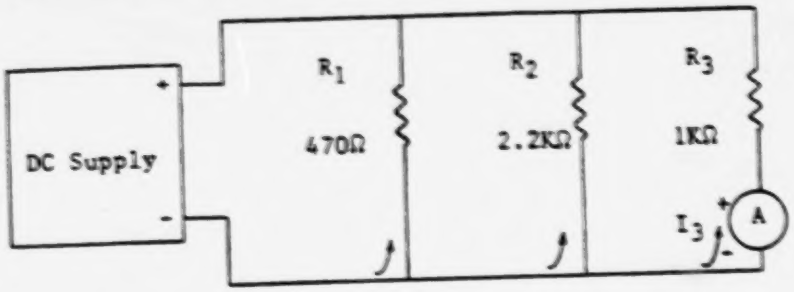
1. Adjust power supply to read 10 volts.


DC supply
+
-
R_1
470Ω
R_2
2.2KΩ
R_3
1KΩ
I_1
+
-
A

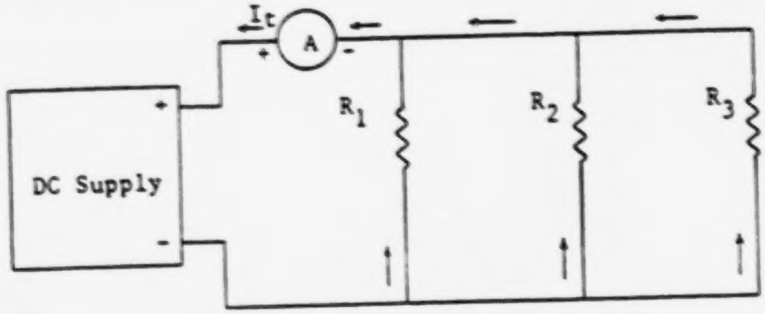
2. Connect ammeter in series with R_1. Observe polarity. Record current I_1 ____________________.


DC Supply
+
-
R_1
470Ω
R_2
2.2KΩ
R_3
1KΩ
I_2
+
-
A

3. Connect ammeter in series with R_2. Observe polarity. Record current
I_2 ____________________


DC Supply
+
-
R_1
470Ω
R_2
2.2KΩ
R_3
1KΩ
A
+
-
I_3

4. Connect ammeter in series with R_3 . Observe polarity then apply voltage.
Record current I_3 ______________.

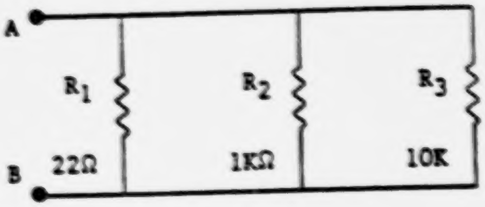

I_t
A
+
-
DC Supply
+
-
R_1
R_2
R_3

5. Connect ammeter in series with R_1 and power supply as shown. Observe polarity, then apply voltage. Record current I_t ____________________

6. The results to this experiment should verify that the sum of the branch currents equal the total circuit current.

7. Write an equation which expresses the current relationship in parallel circuits.

5. Connect circuit as shown:



6. Using an ohmmeter measure the circuit resistance at points A and B.
R_t ____________

7. Compute the resistance total for this circuit.
R_t ________________

8. Does this compare with measured value in step 6? ________________

9. State in your own words the law for the total resistance in any parallel network.

PARALLEL RESISTANCE CIRCUITS

Lab Sheet #8

OBJECTIVES

To observe how parallel resistance circuits operate
To practice wiring parallel resistance circuits
To develop skills in testing and measuring parallel circuits
To develop skills in troubleshooting parallel circuits

MATERIALS REQUIRED

DMM
VTVM OR VOM
Solderless Breadboard
Resistors: 4.7k, 10k, 15k, and 33k

INTRODUCTION

In these Projects you will connect the resistors in different parallel circuits. Then you will make the indicated measurements. Be sure that you have studied the reading assignment before starting these Projects. Reflect on your observations while doing these Projects, and relate them to the laws and theories for parallel circuits. For example, one of the laws states that the total resistance of a parallel circuit is less than the smallest resistor. Watch to see if this, and the other laws, are true for your circuits.

PROJECT 1: Two Parallel Resistors

1. Measure the resistance of a 4.7kohms and 10kohms resistor. Record.

R1 (4.7k):________kohms

R2 (10k):________kohms

2. Calculate the resistance of these two resistors in parallel.

$$R_T = \frac{R1 \times R2}{R1 + R2} = \underline{\qquad\quad} k \quad \text{or} \quad R_T = \frac{1}{1/R1 + 1/R2} = \underline{\qquad\quad} k$$

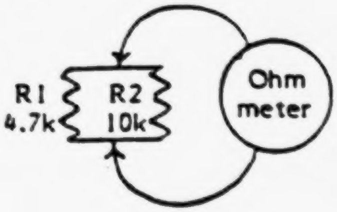


Figure 1

3. Connect the two resistors in parallel (Figure 1) and measure the resistance with the ohmmeter. Record.

R_T = ________kohms. Is it the same as in STEP 2?

YES/NO

PROJECT 2: Three Parallel Resistors

1. Measure and record the value of these resistors:

R1 (10k):_______kohms   R2 (15k):_______kohms   R3 (33k):_______kohms

2. Calculate the resistance of the three resistors connected in parallel.

$$R_T = \frac{1}{1/R1 + 1/R2 + 1/R3} = \underline{\hspace{5cm}}$$

3. Connect the three resistors in parallel and measure the total resistance (Figure 2). Record.

R_T = ________kohms.

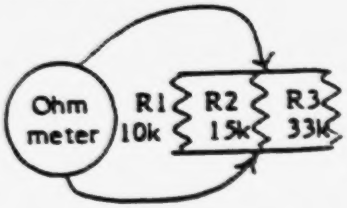


Figure 2

Is it the same as in STEP 2 above? YES/NO

PROJECT 3: Current Flow in a Parallel Circuit

INTRODUCTION

Current flow in any resistor is equal to the voltage across the resistor divided by the value of the resistor. Notice that all parallel resistors have equal voltage applied.

$$I_{R1} = \frac{E_{R1}}{R1}$$

The total current in a parallel circuit is the sum of all individual resistor currents.

$$I_T = I_{R1} + I_{R2} + I_{R3} \cdots$$

The total current is also equal to the voltage applied, and then divided by the total resistance.

$$I_T = \frac{E_{APP}}{R_T}$$

NOTE: When you connect the ammeter in the circuit, you have added some additional resistance to the circuit (the low resistance of the ammeter). The amount of resistance depends on the particular ammeter and the range setting. This small amount of extra resistance may cause some difference between the measured values and the calculated values.

INSTRUCTIONS

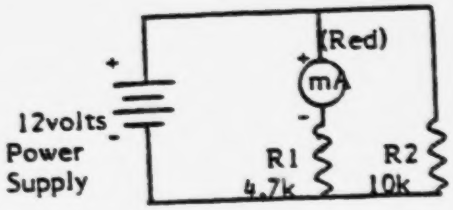


Figure 3

1. Connect the circuit shown in Figure 3. NOTE: This symbol —(mA)— represents the DMM milliammeter. Take extra care to insure that the ammeter is measuring the current through only R1 as shown in Figure 3.

2. Calculate the current through R1.

$$I_{R1} = \frac{12v}{R1} = \_\_\_\_\_\_\_\_ \text{mA.}$$

3. Turn on the voltage and measure the current through R1.

I_{R1} = _______mA. Is it as calculated in STEP 2? YES/NO

4. Calculate $I_{R2} = \frac{12v}{R2} =$ _________mA.

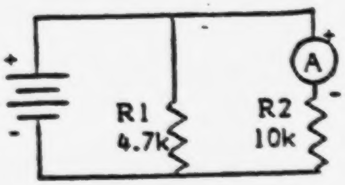


Figure 4

5. Reconnect the circuit with the ammeter in series with only R2. Take extra care to connect it exactly as shown.

6. Apply 12 volts and measure I_{R2}.

I_{R2} = _______mA. Is it the same as calculated in STEP 4? YES/NO

7. Calculate total current. $I_T = I_{R1} + I_{R2} =$ _______mA

$$\text{Also } I_T = \frac{12v}{R_T} = \_\_\_\_\_\_\_\_ \text{mA.}$$

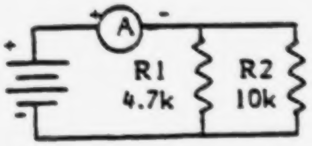


Figure 5

8. Reconnect the ammeter in series with R1 and R2. Apply 12 volts and measure I_T = __________mA.

9. Compare your measured and calculated values for I_T.

Are they the same? YES/NO

PROJECT 4: Power Dissipated in Parallel Resistors

INTRODUCTION

Each resistor dissipates power in a circuit. That is, each generates a certain amount of HEAT in proportion to the electrical POWER within the resistor. You will not be able to feel the heat because is minimal. It is important to understand that each resistor is physically capable of dissipating only a certain amount of power (that is, only get so hot) before it is damaged. The most common maximum wattage ratings used are 1/8 watt, 1/4 watt, 1/2 watt and 1 watt.

The power in any resistor can be calculated using any one of three formulas:

$$P_R = \frac{E^2}{R} \quad \text{or} \quad E_R \times I_R \quad \text{or} \quad I^2_R \times R$$

Since you do not have a watt meter to measure the power in your circuit, you must calculate power using one of the formulas directly above.

INSTRUCTIONS

1. Using the measured values from PROJECT 3, calculate the power in each resistor and the total power in the circuit of PROJECT 3. Complete the table below using each formula for comparison. Be sure to use only the voltage and current for R1 to calculate the R1 power. The same applies to R2.

TABLE 1

	$\frac{E^2}{R} = P$	$I^2 \times R = P$	$E \times I = P$
P_{R1}	________	________	________
P_{R2}	________	________	________
Add each column. P_T	________	________	________

2. Calculate the total power dissipated using each formula. Compare these calculations with the total power calculated above in Table 1. Some slight difference is expected due to calculator rounding-off and measurement error.

$P_T = E_{applied} \times I_T =$ ________ milliwatts(mW).

$P_T = I_T^2 \times R_T =$ ________ milliwatts(mW).

$P_T = \frac{E^2_{applied}}{R_T} =$ ________ milliwatts(mW).

SUMMARY

You should have observed the truth of each important formula provided for parallel resistance circuits. These are the primary tools used to solve all parallel resistance circuit problems. Be sure that you understand them before going on to the next Project.

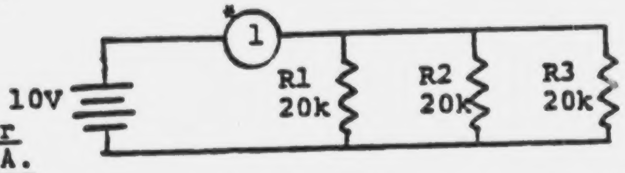
PROJECT 5: Troubleshooting Parallel Resistance Circuits (Self Evaluation)

INSTRUCTIONS

Do not do this Project during lab period. Greater learning will occur by doing it some time after you have done this lab work. Go directly to the next Lab Sheet.

In the following troubleshooting problems, there is only one trouble (a "short" or an "open") in each circuit. Select the best response for each problem. Check your responses with the correct answers at the end of Project 6.

1.

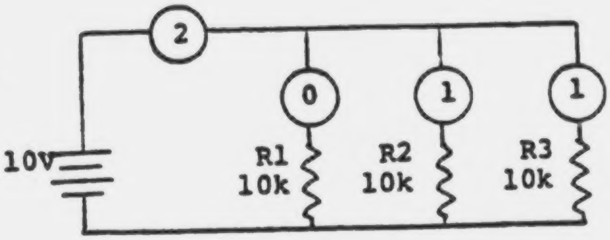

*
1
10V
R1
20k
R2
20k
R3
20k

*NOTE: All meter readings are mA.

a. R1 shorted b. R1 open c. R2 shorted

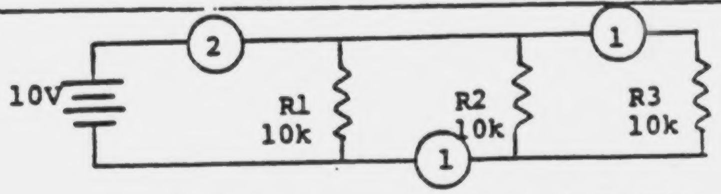
NOTE: All meter readings are mA.

2.


2
0
1
1
10V
R1
10k
R2
10k
R3
10k

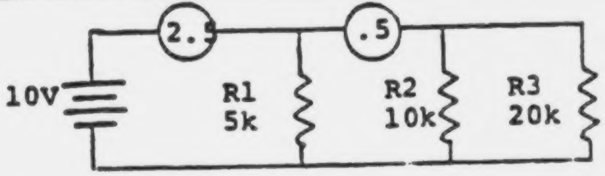
a) R1 shorted b) R1 open c) R3 open

3.


2
1
10V
R1
10k
R2
10k
1
R3
10k

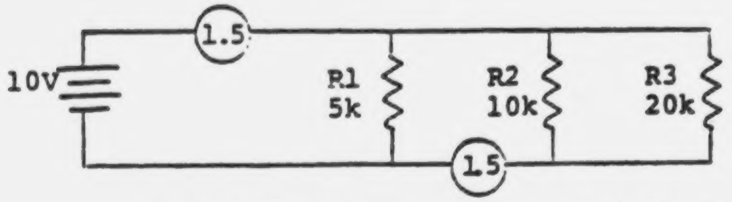
a) R1 open b) R2 open c) R3 open

4.


2.5
.5
10V
R1
5k
R2
10k
R3
20k

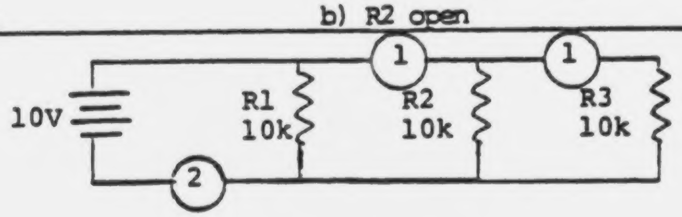
a) R1 open b) R2 open c) R3 open

5.


1.5
10V
R1
5k
R2
10k
R3
20k
1.5

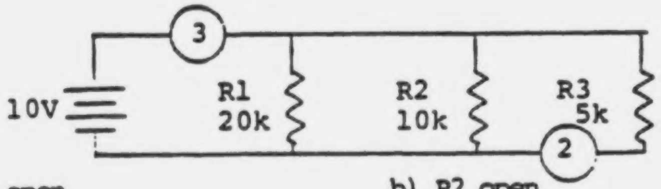
a) Rl open
b) R2 open
c) R3 open

6.


1
1
10V
R1
10k
R2
10k
R3
10k
2

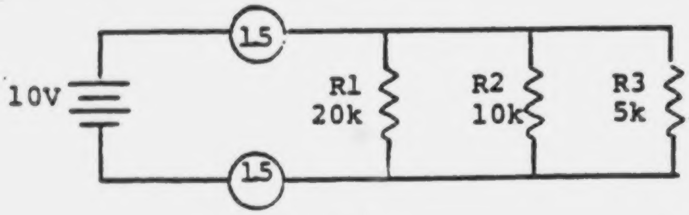
a) Rl open
b) R2 open
c) R3 open

7.


3
10V
R1
20k
R2
10k
R3
5k
2

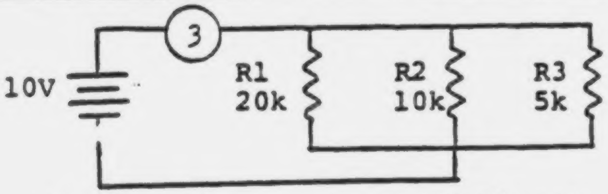
a) Rl open
b) R2 open
c) R3 open

8.


1.5
10V
R1
20k
R2
10k
R3
5k
1.5

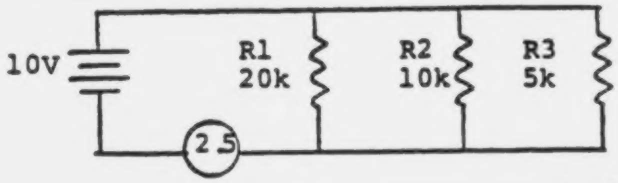
a) Rl open
b) R2 open
c) R3 open

9.

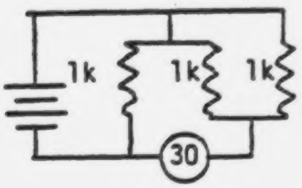

3
10V
R1
20k
R2
10k
R3
5k

a) Rl open
b) R2 open
c) R3 open

10.


10V
R1
20k
R2
10k
R3
5k
2.5

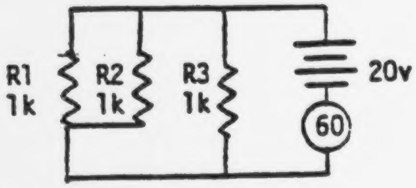
a) Rl open
b) R2 open
c) R3 open



11. What is the battery voltage?

a. 15v
b. 30v
c. 45v
d. 60v

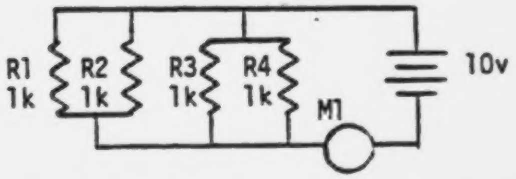
12.


R1
1k
R2
1k
R3
1k
20v
60

How much power is dissipated in R2?

a. 20mw b. 200mw c. 400mw d. 1200mw

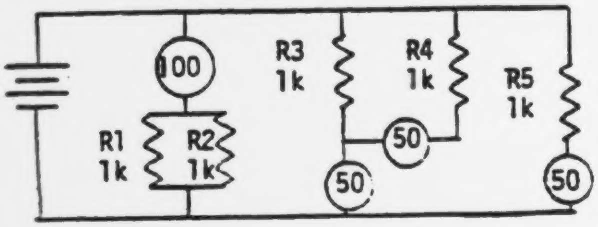
13. Meter M1 would read______ if R2 were shorted.


R1
1k
R2
1k
R3
1k
R4
1k
M1
10v

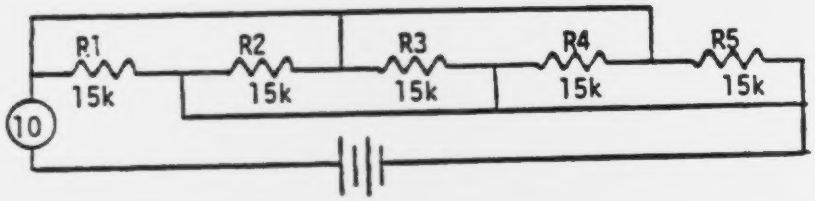
a. low b. high c. volts d. time

14. Is there a trouble in this circuit?

a. NO. b. YES, R1 open. c. YES, R3 open


100
R1
1k
R2
1k
R3
1k
R4
1k
R5
1k
50
50
50

15. What is the battery voltage? (HINT: Re-draw this circuit.)


R1
15k
R2
15k
R3
15k
R4
15k
R5
15k
10

a. 10v
b. 15v
c. 25v
d. 30v
e. 45v

Check your answers to the above quiz on the last page of this Lab Sheet.

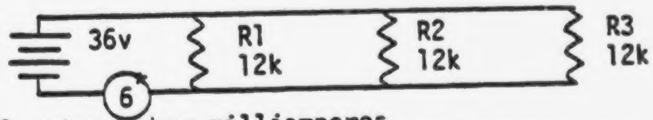
Complete PROJECT 6: Troubleshooting Quiz. Put your responses on an answer sheet and hand it in to your instructor when directed.

PROJECT 6: Troubleshooting Quiz.

INSTRUCTIONS

Select the best response in each set of answers for each problem. Meters(mA) show actual current flowing. There is only one trouble in each circuit and only one correct answer.

1.


36v
R1
12k
R2
12k
R3
12k
6*

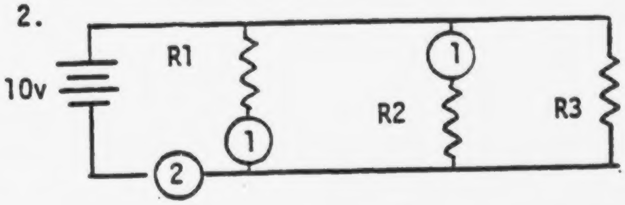
a. R3 open

b. R3 shorted

c. R2 and R3 shorted

*All meters show milliamperes.

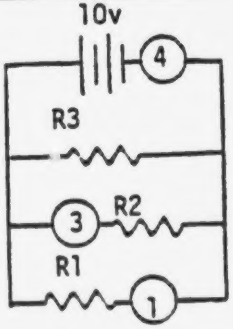
2.


10v
R1
1
R2
R3
1
2

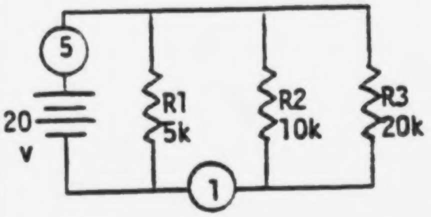
a. R1 open
b. R2 open
c. R3 open
d. R3 shorted

3.

a. R1 open
b. R2 open
c. R3 open
d. R3 shorted

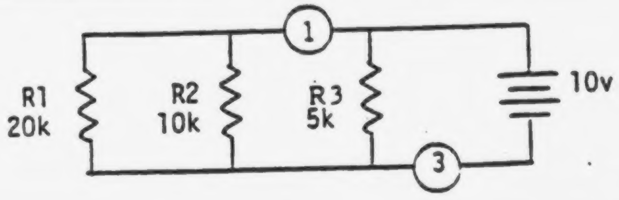

10v
4
R3
3
R2
R1
1

4.


5
20
v
R1
5k
R2
10k
R3
20k
1

a. R1 open
b. R2 open
c. R3 open
d. R3 shorted

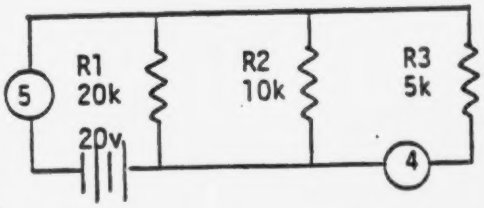
5.


1
R1
20k
R2
10k
R3
5k
10v
3

a. R1 open
b. R2 open
c. R3 open

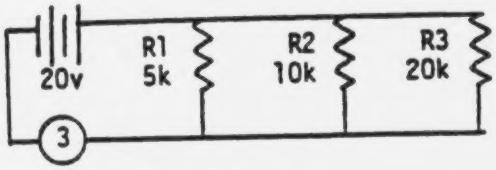
d. R3 shorted

6.


5
R1
20k
R2
10k
R3
5k
20v
4

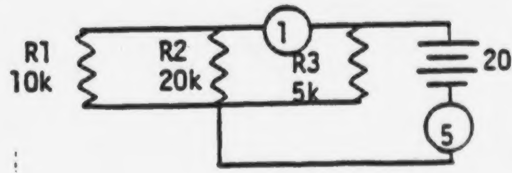
a. R1 open
b. R2 open
c. R3 open
d. R3 shorted

7.


20v
R1
5k
R2
10k
R3
20k
3

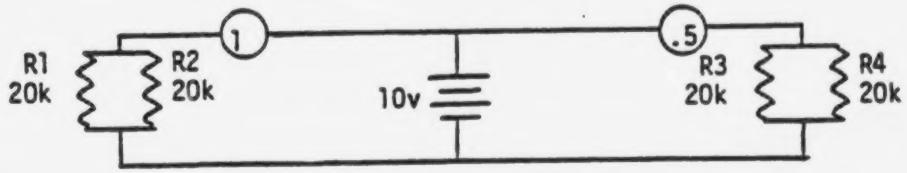
a. R1 open
b. R2 open
c. R3 open
d. R3 shorted

8.


R1
10k
R2
20k
R3
5k
1
20v
5

a. R1 open
b. R2 open
c. R3 open
d. R3 shorted

9.


R1
20k
R2
20k
1
10v
.5
R3
20k
R4
20k

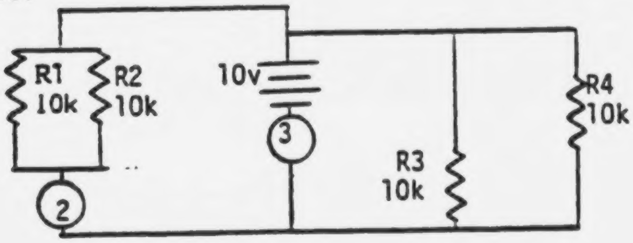
a. R1 open

b. R2 open

c. R3 open

d. R3 shorted

10.

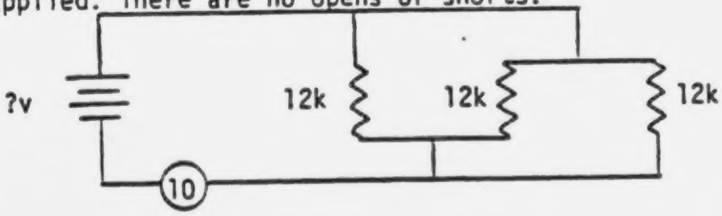

R1
10k
R2
10k
10v
3
2
R3
10k
R4
10k

a. R1 open
b. R2 open
c. R3 open
d. R3 shorted

---

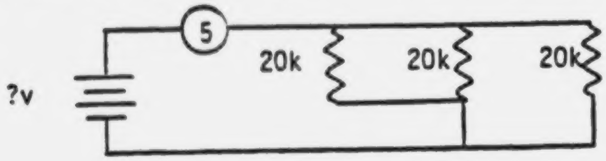
11. Find the voltage applied. There are no opens or shorts.

a. 10v
b. 20v
c. 30v
d. 40v


?v
12k
12k
12k
10

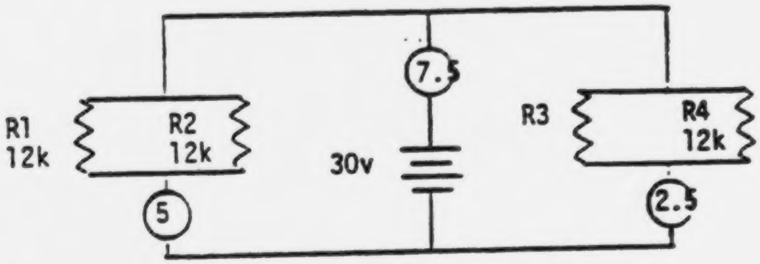
---

12. Find the voltage applied. There are no opens or shorts.


5
?v
20k
20k
20k

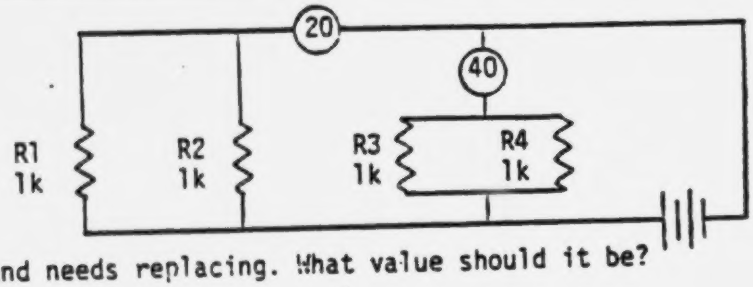
a. 6.6v
b. 18.7v
c. 33.3v
d. 66.7v

13. R3 is open and burned so badly the color code can not be determined. It is known that total current should be 10mA with R3 in the circuit with the other resistors. What value resistor should be used to replace R3?


R1
12k
R2
12k
7.5
30v
R3
R4
12k
5
2.5

a. 12k   b. 24k   c. 6k   d. 1 watt,5%,1k

14.


20
40
R1
1k
R2
1k
R3
1k
R4
1k

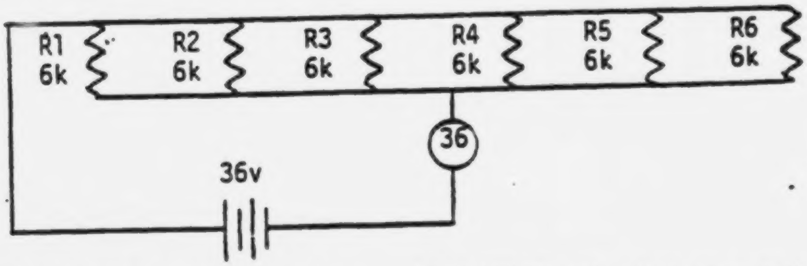
R1 is open and needs replacing. What value should it be?

a. 500 Ω,1 watt   b. 1k Ω,1/4 watt   c. 1k Ω,1/2 watt   d. 1k Ω,5%

---

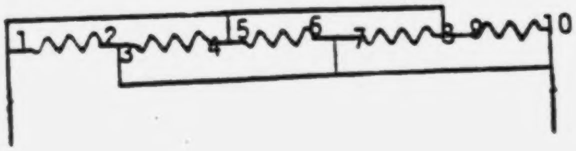
15. Is there a trouble in this circuit?

a. NO   b. YES, there is a short.   c. Yes, there is an open.


R1
6k
R2
6k
R3
6k
R4
6k
R5
6k
R6
6k
36
36v

1 b; 2 b; 3 b; 4 b; 5 a; 6 b; 7 a; 8 c;
9 a; 10 b; 11 a; 12 c; 13 b*; 14 c;
NOTE: 13 b*: Meter would be high, and
may burn out -- then current would be 0.

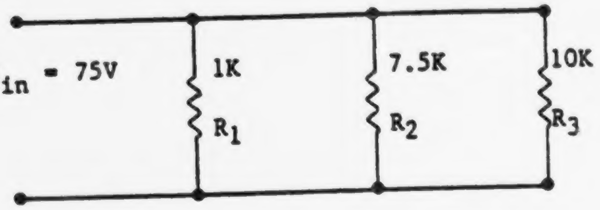
15 d HINT: Number ends and redraw.


1
2
3
4
5
6
7
8
9
10

Self Test

Directions Do the following problems.

1.



E_{in} = 75V
1K
R_1
7.5K
R_2
10K
R_3

P_t = ______________________

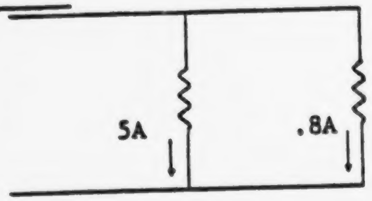
P_1 = ______________________

P_2 = ______________________

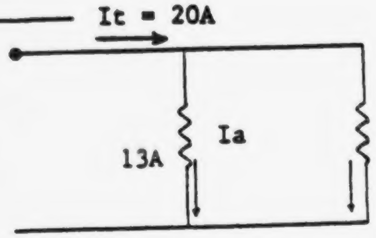
P_3 = ______________________

2. By inspection find the missing quantities:

(a) I_t = __________

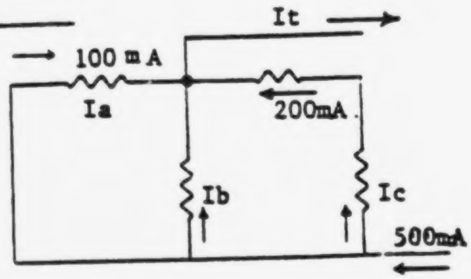


(b) I_b = __________



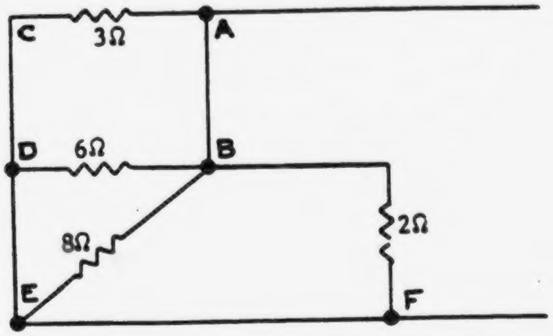
It = 20A
13A
Ia
Ib

(c) I_b = __________

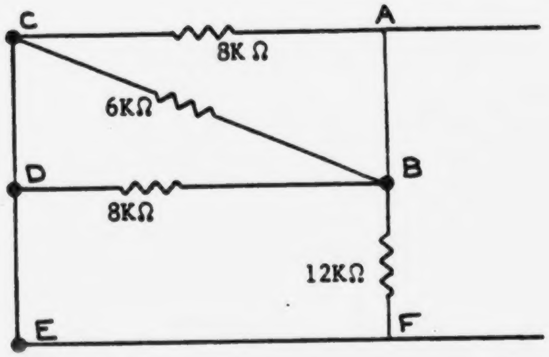


It
100 mA
Ia
200mA
Ib
Ic
500mA

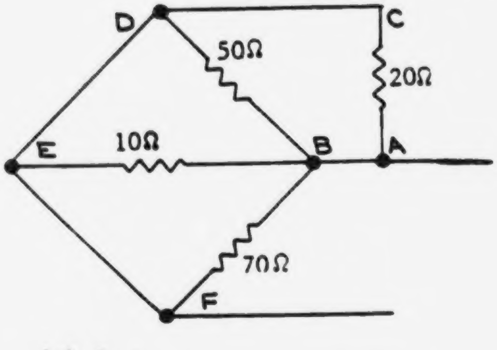
3. Solve for R_t


C
3Ω
A
D
6Ω
B
8Ω
2Ω
E
F

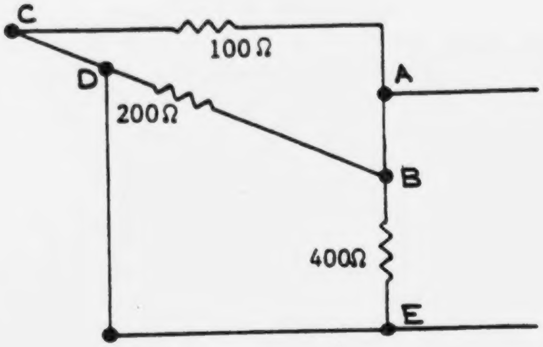
(a) R_t = ____________


C
8K Ω
A
6KΩ
D
8KΩ
B
12KΩ
E
F

(b) R_t = ____________


D
C
50Ω
20Ω
E
10Ω
B
A
70Ω
F

(c) R_t = ____________


C
100 Ω
D
A
200Ω
B
400Ω
E

(d) R_t = ____________

SELECT THE PROPER ANSWER

4. With three 6K connected in parallel, their combined equivalent resistance equal:

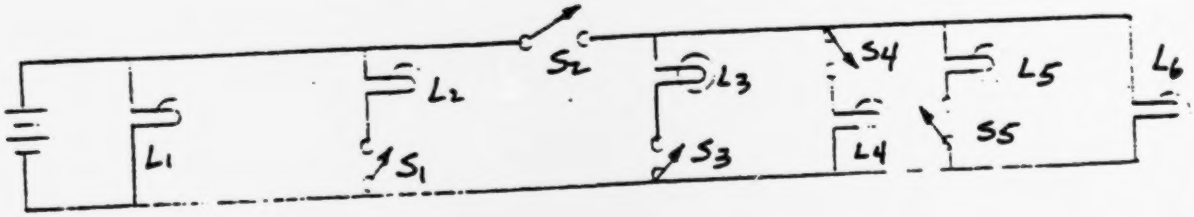
a. ½K b. 1K c. 2K d. 18K

5. Two resistors are connected in parallel, if each dissipates 20 watts, total power consumed is:

a. 20 watts b. 100 watts c. 50 watts d. 40 watts

6. Five 20 Meg resistors connected across 24 volts allows a current of:

a. 6μa b. .6μa c. .006ma d. .06μa



INSTRUCTIONS: (Questions 1- 5)

Using the schematic above select the correct answer for the switch conditions stated in each question. All lamps and switches are good (i.e. there are no "troubles"). All switches are OFF (open) unless stated otherwise.

1. S5 and S2 closed (ON). Which lamps are lit (ON)?
   a. L1, L2, L3, L4, L5
   b. L1, L2, L3, L4, L5, L6
   c. L2, L5
   d. L1, L5, L6

2. S5, S1, S4 ON. Which lamps are not lit?
   a. L3, L4, L5, L6
   b. L1, L4, L5
   c. L2, L3
   d. L3, L5, L6

3. Which switches must be on to light L3, L5, and L6?
   a. S3, S5
   b. S5, S2, S3
   c. S1, S2, S3, S4
   d. S1, S3, S4, S5

4. Switches S2, S3, and S4 are ON. Which lamps are lit?
   a. L1, L5, L3, L4
   b. L2, L3, L4
   c. L1, L3, L4, L5
   d. L2, L3, L4, L5, L6

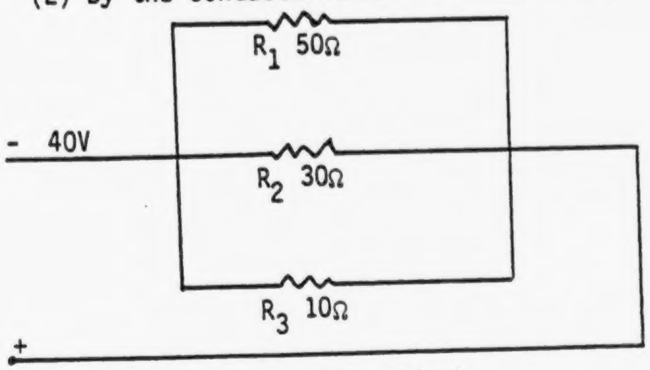
5. All switches are ON except S5. Which lamps are lit?
   a. L1, L2, L3, L4, L6
   b. L1, L2, L3, L4
   c. L1, L5, L2
   d. L1, L6

Name________________________________

Test B "PARALLEL CIRCUITS"

Directions Do the following problems.

1. Calculate from information given in the circuit below, the total resistance of the parallel circuit (1) by the current method, (2) by the conductance method. Show computations.

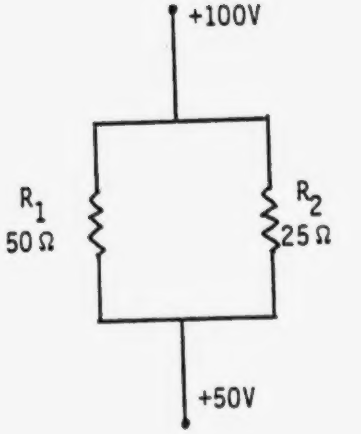


R_t=____________________

(a) computation by current method

(b) computation by conductance

2.


+100V
R1
50 Ω
R2
25 Ω
+50V

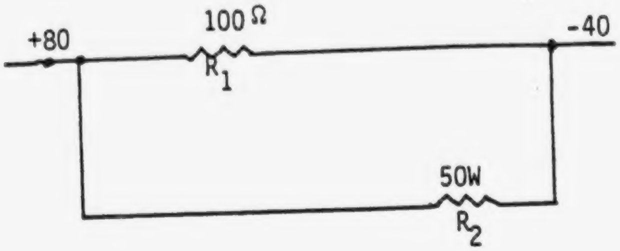
I_1 ______________________

I_2 ______________________

P_1 ______________________

P_2 ______________________

3.


+80
100 Ω
R1
-40
50W
R2

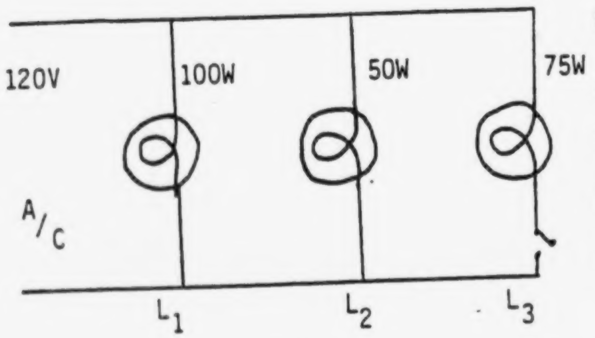
R_2 ______________________

P_1 ______________________

I_1 ______________________

I_2 ______________________

4.


120V
A/C
100W
50W
75W
L1
L2
L3

P_T = ______________________

I_{L_1} = ______________________

I_{L_3} = ______________________

R_{L_1} = ______________________

R_{L_2} = ______________________

5. In any parallel circuit the resistance total will always be ______________ than the resistance of any branch.

6. Find the total conductance in mhos for the following branches:

$G_1 \cdot$ 15 mhos $G_2 \cdot$ .07 mho $G_3 \cdot$ 8000 umhos

G_t = ______________________

7. Total current in any parallel circuit is equal to

a. $I_t = I_1 = I_2 = I_3$

b. $I_t = I_1 - I_2 + I_3$

c. $I_t = \frac{E_t}{R_2}$

d. $I_t = I_1 + I_2 + I_3$

8. Total voltage in any parallel circuit is equal to

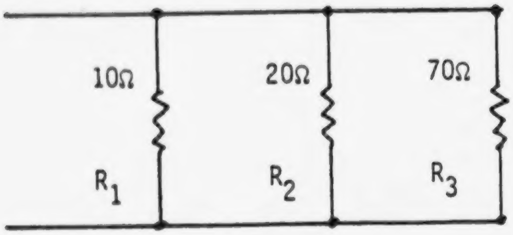
a. $E_t = E_1 + E_2 = E_3$

b. $E_t = I_2 R_2$

c. $E_t = E_t - E_1 + E_2$

d. $E_t = I_2 - R_2$

9.



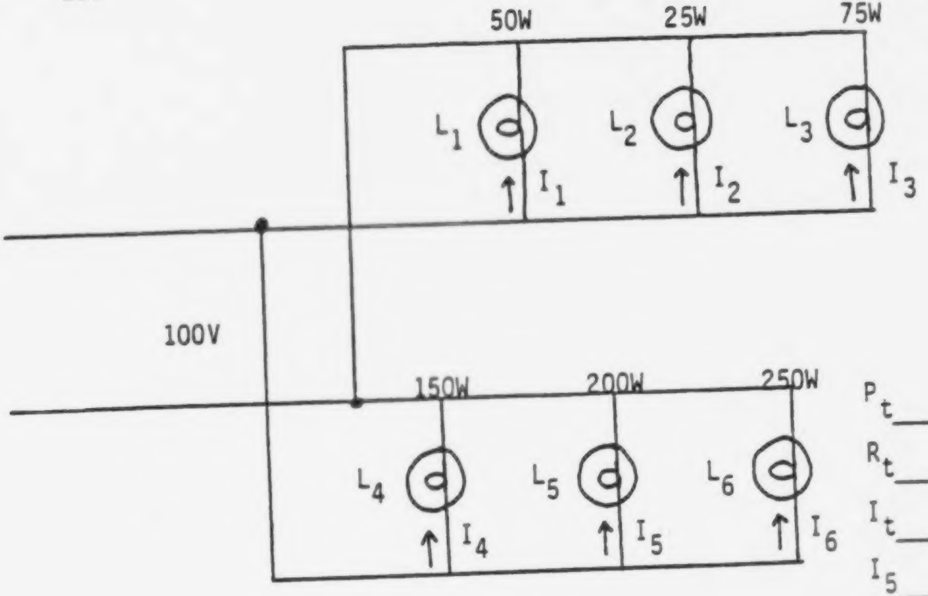
G_t ______________

G_1 ______________

R_t ______________

10. In a parallel circuit P_t = ____________________

11.


50W
25W
75W
L_1
L_2
L_3
I_1
I_2
I_3
100V
150W
200W
250W
L_4
L_5
L_6
I_4
I_5
I_6

P_t __________

R_t __________

I_t __________

I_5 __________

NAME: ____________________

PARALLEL RESISTANCE CIRCUIT

LAB, DAY: ____________________

1/ These resistors are hooked up in parallel. You put in Jm/ current and you will compute. CALCULATE and MEASURE.

A. CALCULATE:

I_1 = ________ ?

I_2 = ________ ?

I_3 = ________ ?

R_2 = ________ ? (unknown)

ET = ________ ?

B. MEASURE:

I_1 = ________ ?

I_2 = ________ ?

I_3 = ________ ?

I_T = ________ ?

E_{R_1} = ________ ?

2/ Put these three resistors into A parallel circuit. You may use The power supply and any of these meters. But you may not use an ohmmeter. Put in any voltage you wish, but keep it ~~below~~ 15 volts.

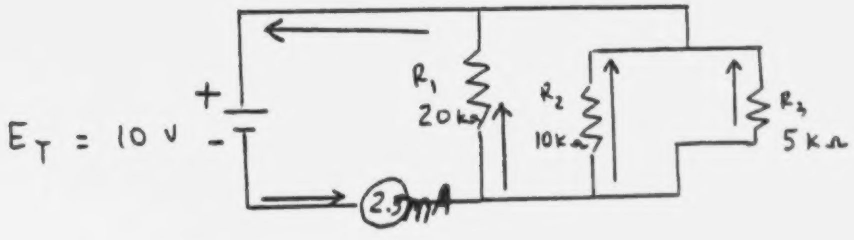
Compute (calculate) (Measure) : R_1: ________ ? R_2: ________ ? R_3: ________ ? R_T: ________ ?

I_1 = ? ____ ? I_2 = ________ ? I_3: ____ ? I_T: ________ ?

Three points each answer.

When you are done, remove the resistors from the easle and turn all knobs fully counter clockwise (to the left).

3/ Troubleshooting parallel resistance circuit (Do not hook up The circuit).



A) R_1 open b) R_2 open c) R_3 shorted d) R_2 shorte

* If R_1 open RALCULATE $R_2 R_3$ in parallel $R_{T_{2,3}}$ = ________ ?

* If R_2 open CALCULATE. $R_1 R_3$ in parallel $R_{T_{1,3}}$ = ________ ?

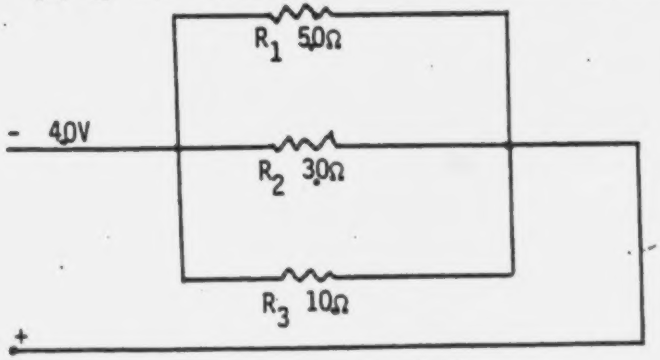
CALCULATE R_1, R_2, R_3 in parallel R_T = ________ ?

Name______________________________

Test [illegible]C "PARALLEL CIRCUITS"

Directions Do the following problems.

1. Calculate from information given in the circuit below, the total resistance of the parallel circuit (1) by the current method, (2) by the conductance method. Show computations.

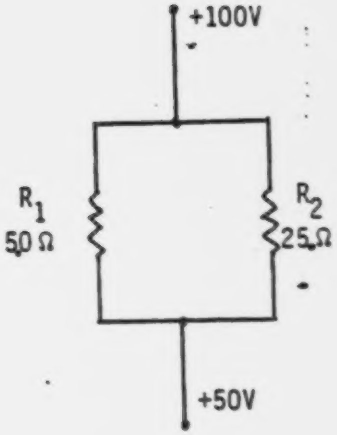


R_t=______________________

(a) computation by current method

(b) computation by conductance

2.


+100V
R_1
50 Ω
R_2
25 Ω
+50V

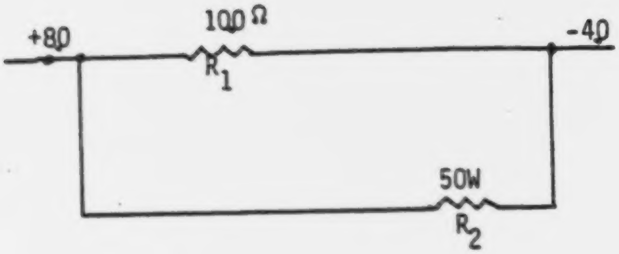
I_1 ______________________

I_2 ______________________

P_1 ______________________

P_2 ______________________

3.


+80
100 Ω
R_1
-40
50W
R_2

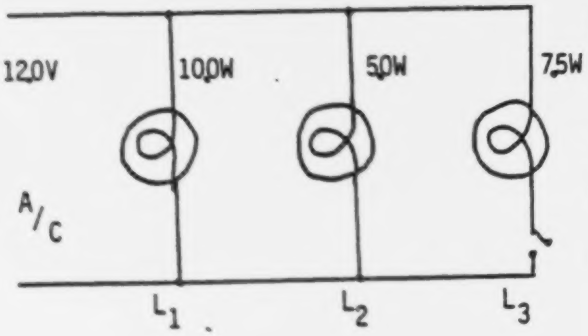
R_2 ______________________

P_1 ______________________

I_1 ______________________

I_2 ______________________

4.


120V
100W
50W
75W
A/C
L_1
L_2
L_3

P_T = ______________________

I_{L_1} = ______________________

I_{L_3} = ______________________

R_{L_1} = ______________________

R_{L_2} = ______________________

5. In any parallel circuit the resistance total will always be ______________ than the resistance of any branch.

6. Find the total conductance in mhos for the following branches:

G_1 1.5 mhos G_2 .07 mho G_3 8000 umhos

G_t = ______________________

7. Total current in any parallel circuit is equal to

a. $I_t = I_1 = I_2 = I_3$

c. $I_t = \frac{E_t}{R_2}$

b. $I_t = I_1 - I_2 + I_3$

d. $I_t = I_1 + I_2 + I_3$

8. Total voltage in any parallel circuit is equal to

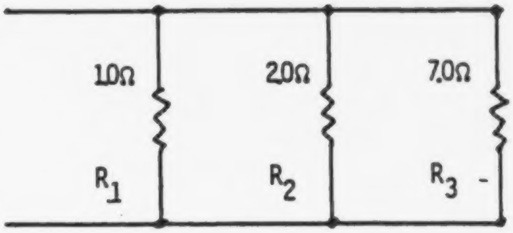
a. $E_t = E_1 + E_2 = E_3$

c. $E_t = E_t + E_1 + E_2$

b. $E_t = I_2 R_2$

d. $E_t = I_2 - R_2$

9.



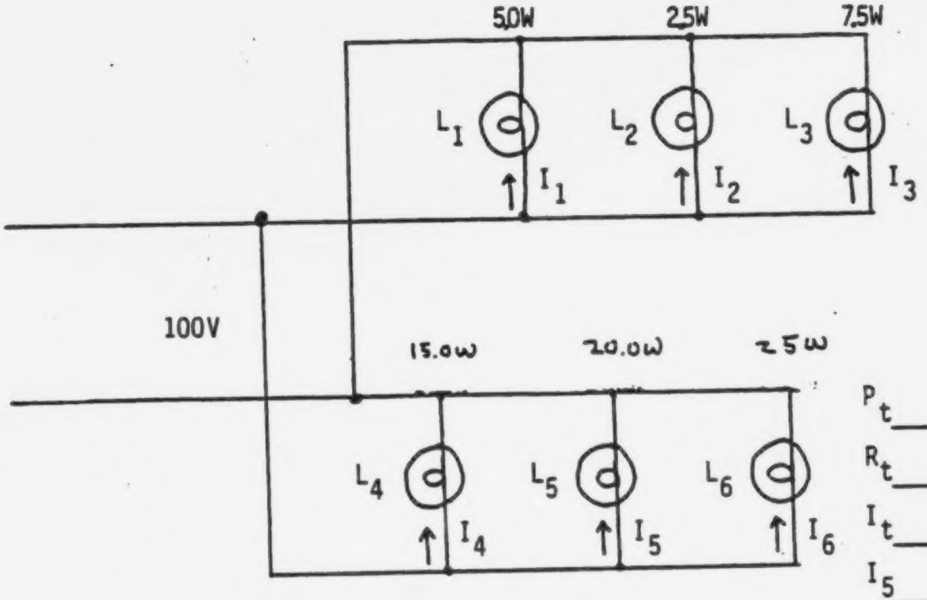
G_t ______________

G_1 ______________

R_t ______________

10. In a parallel circuit P_t = ______________________

11.


5.0W
2.5W
7.5W
L_1
L_2
L_3
I_1
I_2
I_3
100V
15.0W
20.0W
25W
L_4
L_5
L_6
I_4
I_5
I_6

P_t__________

R_t__________

I_t__________

I_5__________

GLOSSARY

ELECTRONICS

TECHNICAL VOCABULARY

PARALLEL RESISTIVE CIRCUITS

conductance
reciprocal method
conductance method
materials
range setting
common maximum wattage ratings

GLOSSARY

ELECTRONICS

RELATED GENERAL VOCABULARY

PARALLEL RESISTIVE CIRCUITS

individualized learning systems
reciprocal
spelled
assume
otherwise
compare with
reflect on

Parallel

[illegible]	[illegible]
Parallel circuit:	mạch song song (có hai hay nhiều con đường cho cường độ chạy).
lighting system:	hệ thống ánh sáng (đèn trong nhà)
organ :	báo; cơ quan
light organ :	hệ thống đèn báo (trong Radio).
characteristic :	đặc tính; đặc sắc.
Relationship :	sự quan hệ
between :	giữa; giữa 2 vật từ cái này đến cái khác.
branch :	nhánh; mạch rẽ.
shunt :	mạch rẽ
correctly (a)	đúng
equavalent :	sự tương đương
equavalent Resistance:	chỉ điện trở tổng trong
listed	[illegible] mạch song song.
power dissipation:	sự tiêu thụ công suất
power dissipated :	công suất tiêu hao (được tiêu thụ điện bằng sức nóng).
reciprocal :	nghịch đảo (có nghĩa $\frac{1}{.....}$) Thí dụ: nghịch đảo của 5 là $\frac{1}{5}$.
information summary :	chỉ dẫn sơ yếu.
The sum of :	tổng số
appropriate method :	phương pháp thích hợp.
network :	mạng lưới làm việc chỉ công việc phải thực hiện. Có nghĩa công việc làm.

$$R_t = \frac{R}{N}$$

chỉ trị số của một điện trở (trong các điện trở có trị số bằng nhau).

chỉ số lượng bao nhiêu điện trở (các điện trở đều bằng nhau trong mạch song song).

điện trở tương đương.

convenient : tiện lợi.

unequal : không bằng nhau

assumed : được cho là

The reciprocal of the sume of The reciprocals : nghịch đảo của tổng nghịch đảo. Thí dụ:

$$R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

(• nghịch đảo có nghĩa là 1 chia cho .....
• của tổng nghịch đảo có nghĩa là nghịch đảo của R_1 là $\frac{1}{R_1}$ cộng với nghịch đảo của R_2 là $\frac{1}{R_2}$ cộng với nghịch đảo của R_3 là $\frac{1}{R_3}$)

• Công thức trên có nghĩa là điện trở tương đương của các điện trở trong mạch song song bằng 1 chia cho tổng nghịch đảo các R_1, R_3, R_3 trong mạch.

Conductance method: phương pháp tính độ dẫn điện.

G (conductance): đơn vị đo của độ dẫn điện

backwards : chuyển ngược chữ từ OHM (Ω) đổi lại thành MHO.

power : công suất viết tắt là P.

material : vật liệu.

approximate : phỏng chừng; phỏng độ; ước chừng.

remain : . còn thừa lại.
. dư số; số dư.

equation : đẳng thức (một đẳng thức có 2 hay nhiều vế giữa dấu bằng (=)

Thí dụ: $E_T = E_1 = E_2 \ldots$

Result : Kết quả

express : nói lên; phát biểu

impection : sự kiểm tra, soát lại.

missing : thiếu, vắng mặt, chưa ghi ra.

power consumed: công suất tiêu thụ.

並聯电阻电路(PARALLEL RESISTIVE CIRCUIT:

light organ：发光樂器(琴).

characteristics：特性.特别的風格.

branches：分支,支线.

conductance：电導.(G)(mho).

reciprocal：倒數,逆數

less than：小於……,比…小.

smallest：最小的,最低的.

referred to：委託.謁詹屬於.有机係.

network：电路網

unequal：不相等的.

convenient：方便,便利.

choose：选,擇.

slide rule：計算尺.

backwards：倒轉.(指前後倒过去)

approximate：大約數.

ELECTRONI RRICULUM

VOCATIONAL TRAININ SSON PLAN # VI

Series/Parallel Circuits

Teaching Materials Source ______________________________

Chapter ______________, pages ______________

Lab Manual pages ______________

Additional Instructor Materials ______________________________

Main concepts student will learn:

The student will be able to:

1. identify series/parallel (combination) circuits in a diagram and list an example of practical uses for each type of circuit arrangement.
2. solve for total resistance utilizing proper formulas and units of measurement for each type of circuit discussed.
3. verify calculated values of voltage, current, and resistance for a series/parallel (combination) circuit by assembling a test circuit and measuring quantities with the proper meter.
4. recite and apply both Ohm's and Kirchhoff's Laws as requested when solving or evaluating series-parallel circuits.

Technical Vocabulary

complex circuits
combination circuits
series/parallel network
series
parallel

Related General Vocabulary

Teaching Activity

same as for Series Circuits

Materials and Notes

Length of Lesson

3 weeks

Evaluation

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of oral or written testing procedures.

-09 Series-Parallel Resistive Circuits

INDIVIDUALIZED LEARNING SYSTEMS

Electronics

EL-BC-09 SERIES-PARALLEL RESISTIVE CIRCUITS

BASIC CONCEPTS

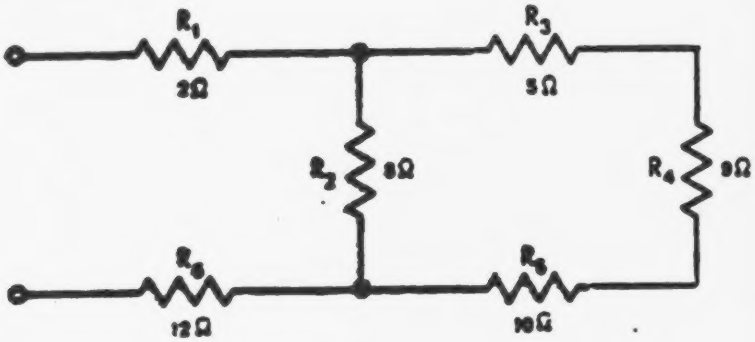
Series and parallel networks are a combination of series and parallel circuit resistances. Such combinations of resistances are frequently used in electrical circuits, particularly electric motor circuits and control circuits for electronic equipment.

INFORMATION SUMMARY

1. All series-parallel circuits can be reduced to one equivalent resistance and can be treated as one series resistance. Generally the total resistance (R_t) is determined in two steps. First, the resistance of the parallel combination is determined as one equivalent resistance. Second, the equivalent resistance and series resistance are added to form one single resistance total.

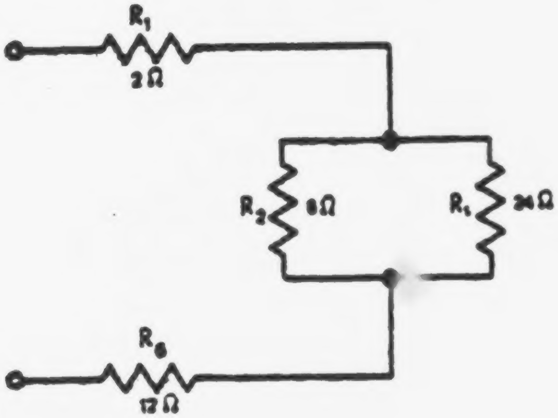
Example given below:

Step I add branch R_3, R_4 and R_5 notice the series resistance in the parallel branch must be added first.



Step II find resistance equivalent of R_2R_x

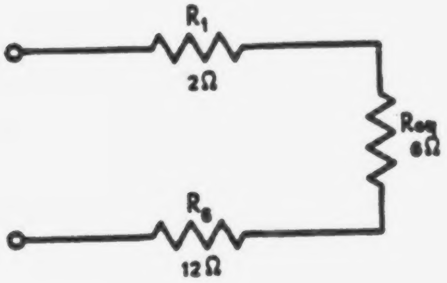
$$R_{eq} = \frac{R_2R_s}{R_2+R_6} = \frac{8 \times 24}{32} = 6\ \Omega$$



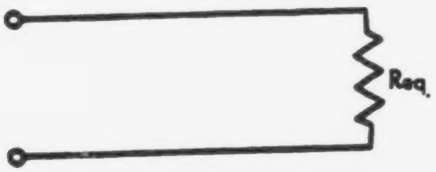
Step III add R_1 + Req + R_6

$2 + 6 + 12$

Req 20 Ω



Final equivalent resistance of circuit



2. When finding current and voltage relationships in series and parallel networks, you will apply this same law as previously stated in series and in parallel circuits.

3. Power in a series-parallel circuit is determined in the same way as for simple series and parallel circuits. Remember as stated before total power dissipated in any circuit is equal to the sum of the quantities of power dissipated by the individual resistances.

$$P_1 = I_1 E_1 \qquad P_1 = \frac{I_1^2}{R_1} \qquad P_1 = \frac{E_1^2}{R_1}$$

$$P_t = P_1 + P_2 + P_3 + \ldots$$

Any one of the above formulas should be used when appropriate.

OBJECTIVE

1. Given a set of series-parallel combinations you will determine the resistance equivalent of each.

2. Given a circuit diagram of series-parallel networks consisting of a voltage source you will calculate the correct current values.

3. From schematic diagram you will determine voltage at various points along a circuit.

4. Given a schematic of a series - parallel network you will verify circuit computations with proper laboratory test equipment.

5. You will be able to calculate power dissipation in a series parallel circuit.

Directions

Do the following

Learning Opportunities

1. Look up:
   key index words for basic information.
2. Do:
   Experiment #1
3. Do:
   Experiment #2
4. Do:
   Experiment #3
5. Do:
   Exercise #1

Reasons

1. To gain better understanding of complex circuits.
2. These experiments will verify basic concepts relating to series parallel-circuits.

Key Index Words

complex circuits

combination circuits

series-parallel network

series

parallel

Name: ____________________

Date: ____________________

Period: ____________________

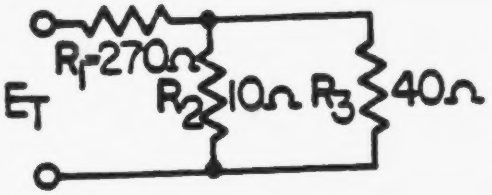
SCORE:

GRADE:

WORKSHEET

COMBINATION CIRCUIT ANALYSIS

Solve the following circuit problems. Be certain to show work and record your answer in the answer box.

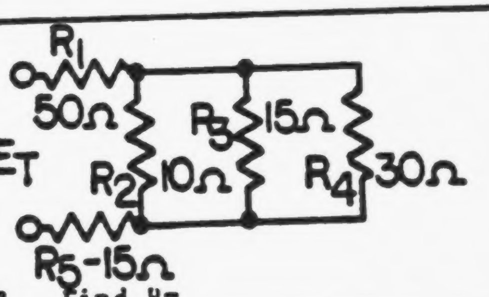


R_1-270Ω
E_T
R_2 10Ω
R_3 40Ω

1. Find the total resistance in the above circuit.

Show work

1. ☐



R_1
50Ω
R_3 15Ω
E_T
R_2 10Ω
R_4 30Ω
R_5-15Ω

2. Find R_T

Show work

2. ☐

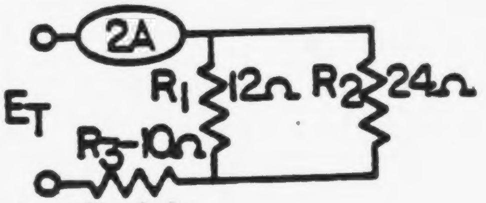
3A. Draw a combination circuit which contains the following resistors; a 39 ohm and 27 ohm connected in series with two parallel resistors each having a value of 33 ohms.

3B. Find the total resistance of the circuit.

Show work

3A. SCHEMATIC

3B. ☐



2A
E_T
R_1 12Ω
R_2 24Ω
R_3-10Ω

4. Find R_T
5. Find E_T

Show work

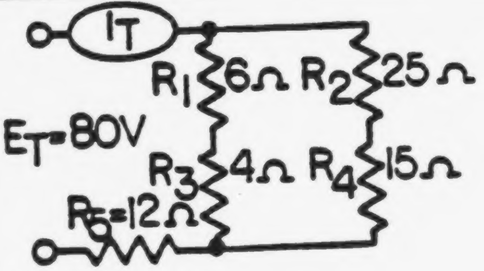
4. ☐

5. ☐

Name: ____________________

Date: ____________________

Period: ____________________


I_T
R_1 6Ω
R_2 25Ω
E_T=80V
R_3 4Ω
R_4 15Ω
R_5=12Ω

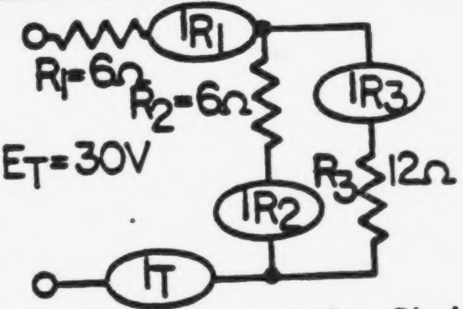
6. Find R_T

7. Find I_T

Show work

6.

7.


IR_1
R_1=6Ω
R_2=6Ω
IR_3
E_T=30V
R_3 12Ω
IR_2
I_T

8. Find R_T

9. Find I_T

10. Find I_{R_1}

11. Find E_{R_1}

12. Find E_{R_2}

13. Find I_{R_2}

14. Find E_{R_3}

15. Find I_{R_3}

Show work

8.

9.

10.

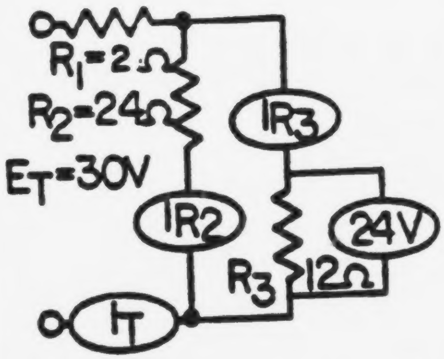
11.

12.

13.

14.

15.


R_1=2Ω
R_2=24Ω
IR_3
E_T=30V
IR_2
24V
R_3 12Ω
I_T

16. Fine E_{R_1}

17. Find I_{R_3}

18. Find I_{R_2}

19. Find I_T

20. Find I_1

Show work

16.

17.

18.

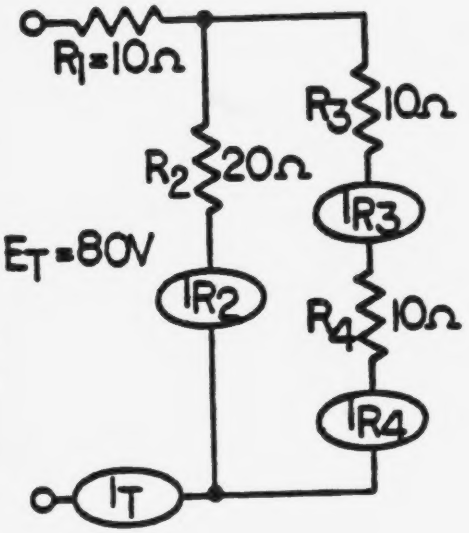
19.

20.

Name: ____________________

Date: ____________________

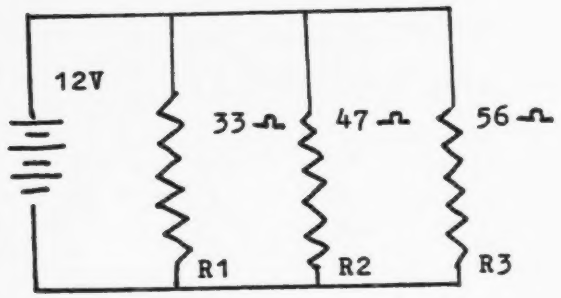
Period: ____________________


$R_1 = 10\Omega$
R_2 20Ω
R_3 10Ω
R_4 10Ω
$E_T = 80V$
I_{R2}
I_{R3}
I_{R4}
I_T

21. Find R_T
22. Find I_T
23. Find E_{R_1}
24. Find E_{R_2}
25. Find I_{R_2}
26. Find I_{R_3}
27. Find I_{R_4}
28. Find E_{R_3}
29. Find E_{R_4}

Show work

21.
22.
23.
24.
25.
26.
27.
28.
29.


12V
33 Ω
47 Ω
56 Ω
R1
R2
R3

IR1=____________

IR2=____________

IR3=____________

IT =____________

RT =____________

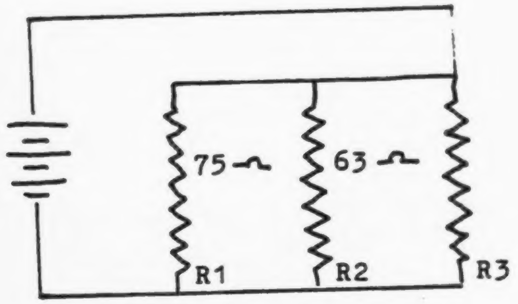
PR1=____________

PR2=____________

PR3=____________

PT =____________

GT =____________


75 Ω
63 Ω
R1
R2
R3

IR1=120ma.

IR3=111ma

VR1=____________

VR2=____________

IR2=____________

VR3=____________

R3 =____________

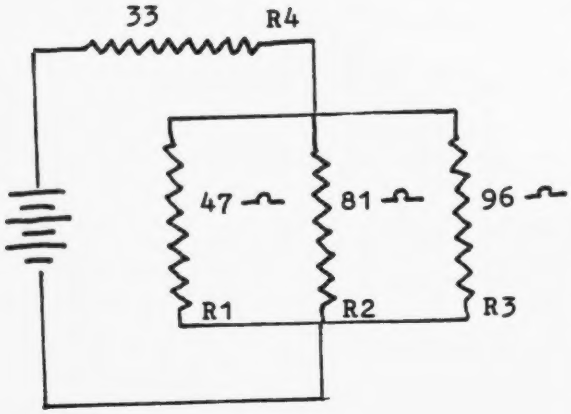
RT =____________

G1=____________

G2=____________

G3=____________

GT=____________


33
R4
47 Ω
81 Ω
96 Ω
R1
R2
R3

IR4=15ma

GR1=____________

GR2=____________

GR3=____________

G1+1+2+3=________________

REQ1-2-3=________________

VReq=____________

VR4=____________

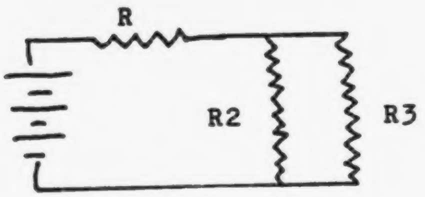
Vt =____________

IR1=____________

IR2=____________

IR3=____________

Fig. #1



V_T=10V
R1=30 Ω
R2=40 Ω
R3=60 Ω
REQ=______
RT =______

PR1=__________
PR2=__________
PR3=__________
PT =__________
VRI=__________
VR2=__________
VR3=__________

IR1=__________
IR2=__________
IR3=__________
IT =__________

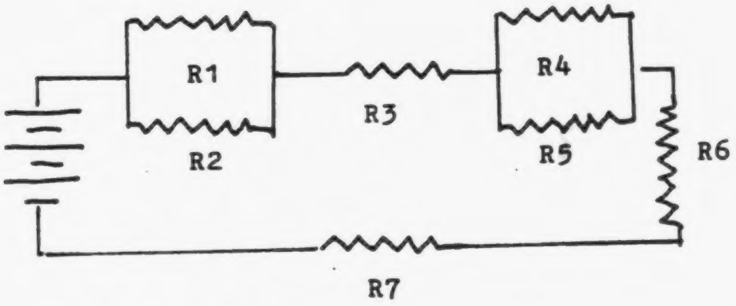
V_T=130V
R_1=20 Ω
R_2=180 Ω
R_3=60 Ω

REq=__________
RT=__________
PR_1=__________
PR_2=__________
PR_3=__________

P_T=__________
VR_1=__________
VR_2=__________
VR_3=__________

IT=__________
IR_1=__________
IR_2=__________
IR_3=1.5A

Fig. #2



VT=__________
VR1=4.55V
VR2=__________
VR3=__________
VR4=__________
VR5=__________
VR6=__________
VR7=__________

RT=__________
R1=__________
R2=__________
R3=12K Ω
R4=__________
R5=__________
R6=4K Ω
R7=__________

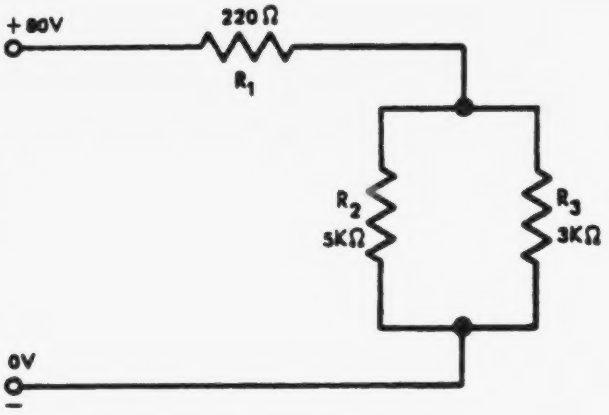
PT=__________
PR1=20.7mw
PR2=__________
PR3=__________
PR4=__________
PR5=105mw
PR6=__________
PR7=.175w

IT=__________
IR1=__________
IR2=__________
IR3=5ma
IR4=__________
IR5=3.49ma
IR6=__________
IR7=__________

EXERCISE #1

Solve the following series-parallel circuits:

1.


+80V
220Ω
R_1
R_2
5KΩ
R_3
3KΩ
0V
−

R_t ______________

I_1 ______________

I_2 ______________

I_3 ______________

I_t ______________

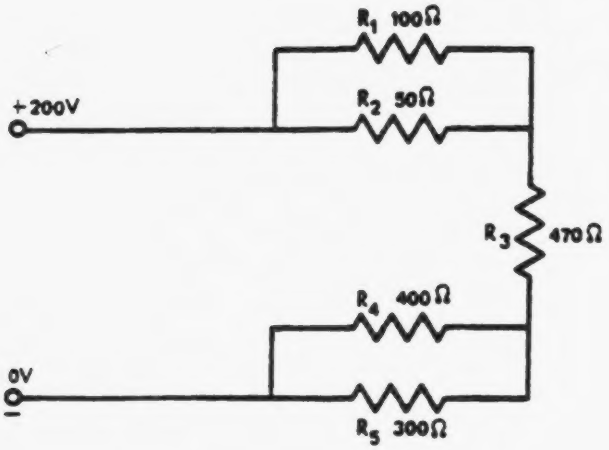
P_1 ______________

P_t ______________

E_3 ______________

E_1 ______________

2.


R_1 100Ω
+200V
R_2 50Ω
R_3
470Ω
R_4 400Ω
0V
−
R_5 300Ω

Find voltage drop across R_3.

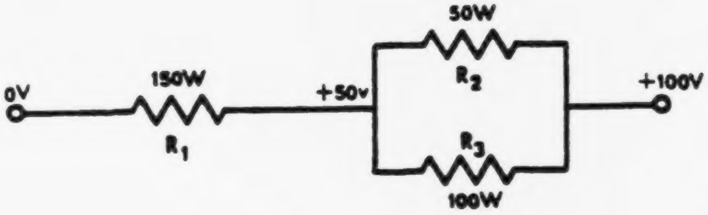
E ______________

Find power dissipated in R_2 .

Watts______________

Exercise #1

3.


50W
0V
150W
+50v
R2
+100V
R1
R3
100W

P_t ____________________

E_2 ____________________

E_1 ____________________

I_1 ____________________

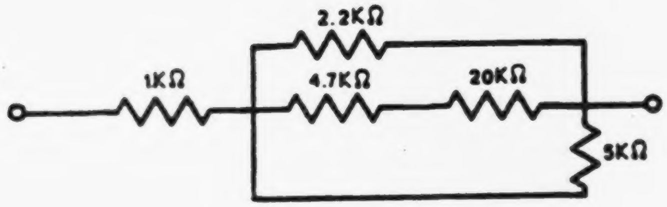
I_2 ____________________

R_2 ____________________

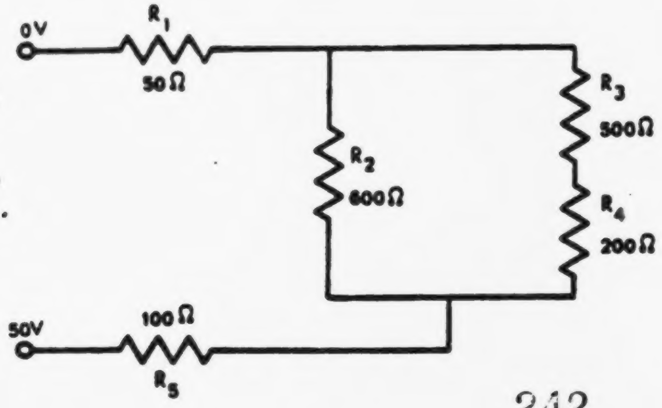
Remember total power dissipated is the sum of the powers dissipated in the individual resistances.

4.

R_t = ____________________


2.2KΩ
1KΩ
4.7KΩ
20KΩ
5KΩ

5.


0V
R1
50Ω
R3
500Ω
R2
600Ω
R4
200Ω
50V
100Ω
R5

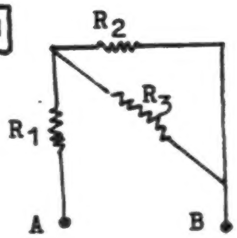
P_3 ____________________

I_3 ____________________

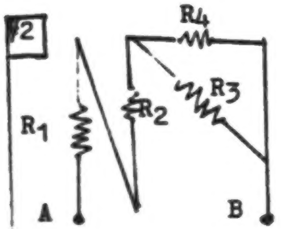
E_5 ____________________

Redraw the Circuits: Series Components vertical and Parallel Components horizontal

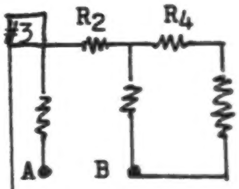
#1



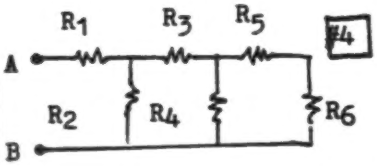
#2


R4
R3
R1
R2
A
B

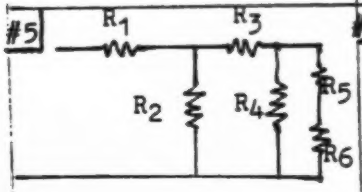
#3



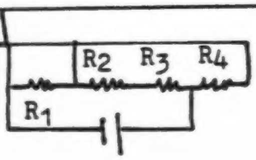
#4


R1
R3
R5
A
R2
R4
R6
B

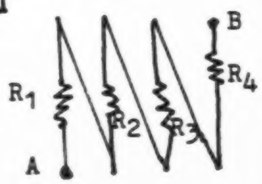
#5


R1
R3
R2
R4
R5
R6

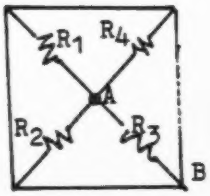
#6



#7


B
R4
R1
R2
R3
A

#8


R1
R4
A
R2
R3
B

Write an Equation for RT for each circuit. Solve for R+ in each circuit. All resistors are 1K .

1.____________________

2.____________________

3.____________________

4.____________________

5.____________________

6.____________________

7.____________________

8.____________________

R_1=10K ~

R_2=10K ~

R_3=10K ~

R_4=100K

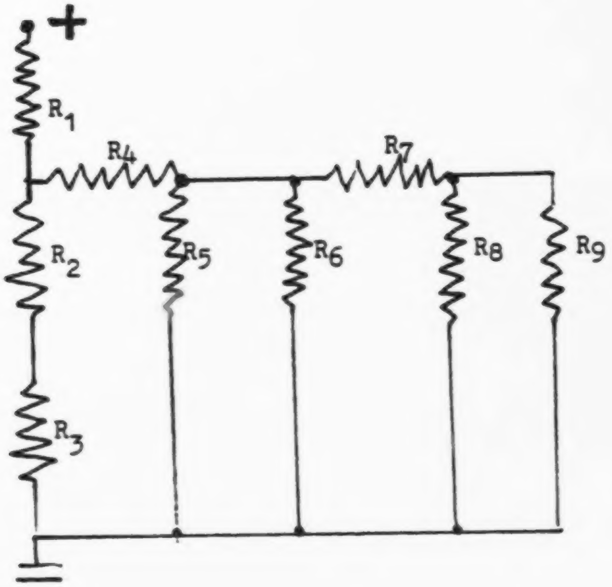
R_5=50K

R_6=75K ~

R_7=10K ~

R_8=50K ~

R_9=15K ~


+
R1
R4
R7
R2
R5
R6
R8
R9
R3

R total =

VT=____________________

VR1=9.9KV

Solve for all other unknowns

Name: ______________________________

1. Solve for the following

E_1

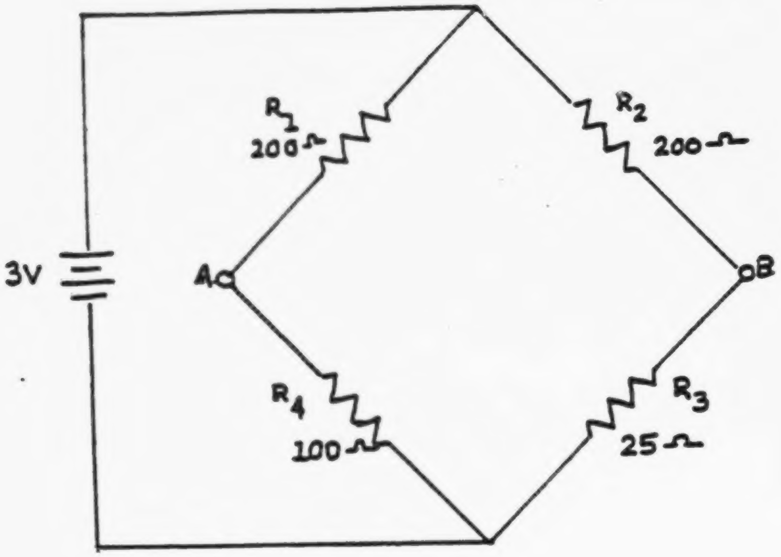
E_2

E_3

E_4

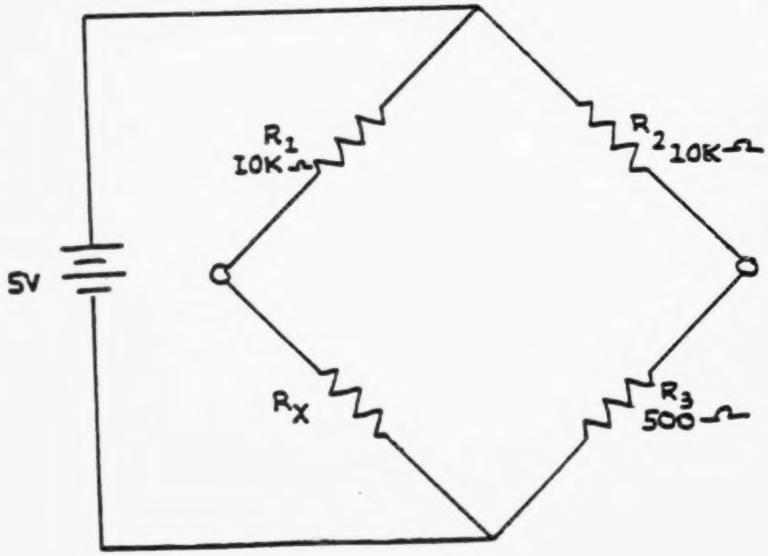
E from A to B

Point A is (+) (-)
with respect to B.



R_1
200 Ω
R_2
200 Ω
3V
A
B
R_4
100 Ω
R_3
25 Ω

2. To have the voltage from "A" to "B" equal zero (0) volts, R_x would have to be ________ ohms.



R_1
10K Ω
R_2
10K Ω
5V
R_X
R_3
500 Ω

Name: ______________________________

1. Solve for the following:

R_T

R_1

R_2

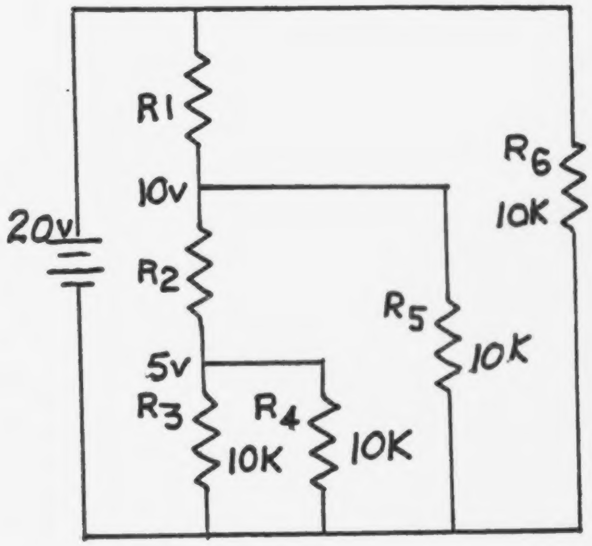
I_1

I_2

I_3

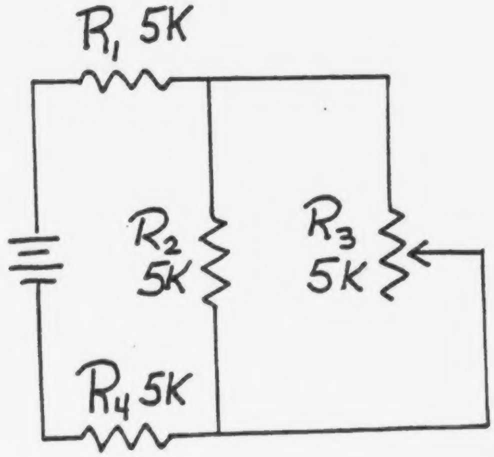
I_6

I_T



R1
10v
20v
R2
5v
R3
10K
R4
10K
R5
10K
R6
10K

2. The resistance in this circuit will vary from ________to ______ ohms.



R1 5K
R2 5K
R3 5K
R4 5K

Name________________________________

BRIDGE CIRCUITS PROBLEM SHEET

#1

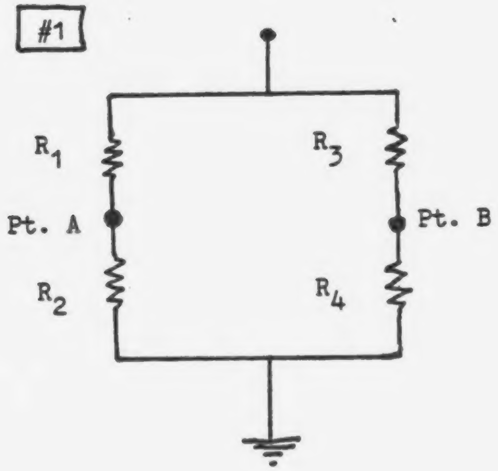


Fig. #1

Given:

R_1=10K

R_2= 5K

R_3=100K

R_4=50K

Eappl. 30VDC

I_{R_1}=200ma

Solve for

ER_1=________________________

ER_2=________________________

ER_3=________________________

ER_4=________________________

IR_2=________________________

IR_4=________________________

With ground as the reference point.

V at pt A is________________

V at pt B is________________

The potential difference between A and B is ________________

#2

Given:

R_1=15K I_1=____________

R_2= 5K I_2=____________

R_3=10K I_3=____________

R_4= 5K I_4=____________

E_+=15y

With ground as the reference point:

V at pt. A is ________________

V at pt. B is ________________

The potential difference between A and B is ____________________.

#3

Find the resistance required to balance the bridge given:

Given:

R_1= 6K

R_2= 4K

R_3=10K

R_4=______

#4

Given:

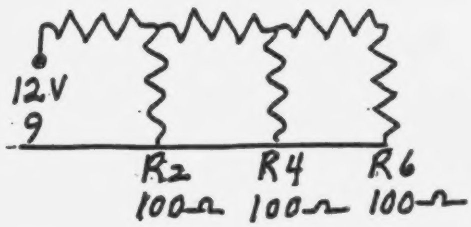
R_1= 2K

R_2= 6 K

R_3=______

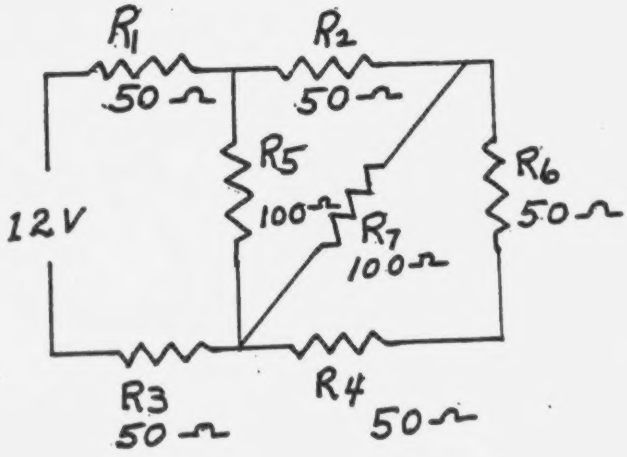
R_4=15K

Name ____________________


12V
9
R2
100Ω
R4
100Ω
R6
100Ω

Compute IT ____________________

Compute VR1 ____________________


R1
50Ω
R2
50Ω
R5
100Ω
R7
100Ω
R6
50Ω
12V
R3
50Ω
R4
50Ω

Compute RT ____________________

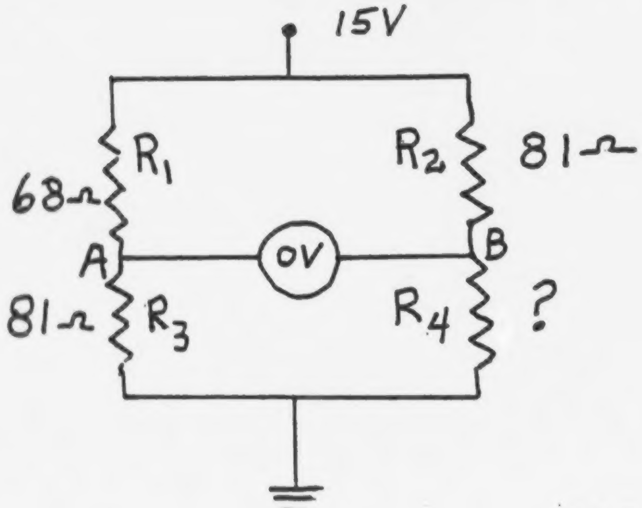
Compute IT ____________________

Compute IR5 ____________________

Compute VR5 ____________________

Compute IR2 ____________________

Compute VR2 ____________________


15V
R1
68Ω
R2
81Ω
A
0V
B
81Ω
R3
R4
?

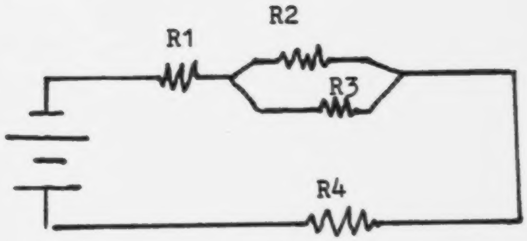
Compute V at Point A ____________________

Compute R4 ____________________

COMBINATION CIRCUITS

Name ______________________________

1.

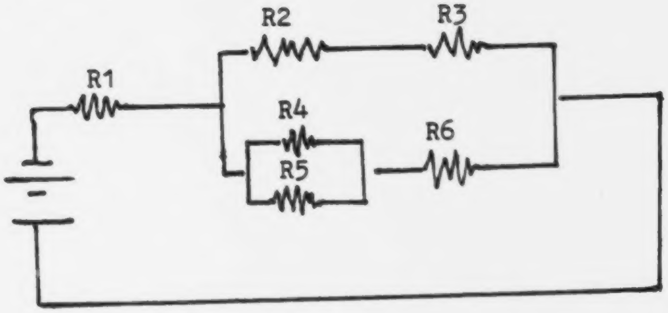


R1=10 Ω
R2=20 Ω
R3=30 Ω
R4=28 Ω
ET=100

RT ________
R4 ________
IT ________
I1 ________
I2 ________
I3 ________
I4 ________
PT ________

E1 ________
E2 ________
E3 ________
E4 ________
P1 ________
P2 ________
P3 ________
P4 ________

2.


R1
R2
R3
R4
R5
R6

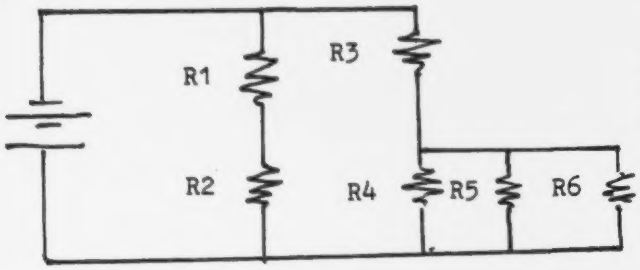
R1=100 Ω
R2=50 Ω
R3=50 Ω
R4=60 Ω
R5=40 Ω
R6=76 Ω
ET=300

RT____
I1____
I2____
I3____
I4____
I5____
I6____
IT____

E1 ____
E2 ____
E3 ____
E4 ____
E5 ____
E6 ____

P1 ______
P2 ______
P3 ______
P4 ______
P5 ______
P6 ______
P6 ______

3.


R1
R2
R3
R4
R5
R6

ET=90 v
R1=10 Ω
R2=20 Ω
R3=18 Ω
R4= 4 Ω
R5= 5 Ω
R6=20 Ω

RT ________
IT ________
I1 ________
I2 ________
I3 ________
I4 ________
I5 ________
I6 ________

E1 ________
E2 ________
E3 ________
E4 ________
E5 ________
E6 ________

P1________
P2________
P3________
P4________
P5________
P6________
PT________

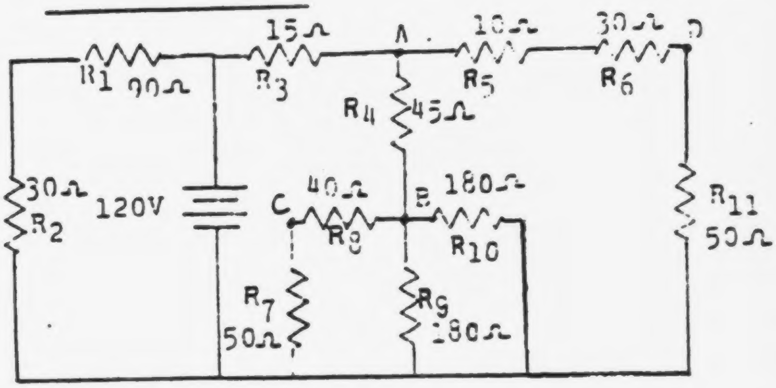
HINT: Re Draw.

ELECTRONICS TECHNOLOGY

NAME________________________ PERIOD________________________

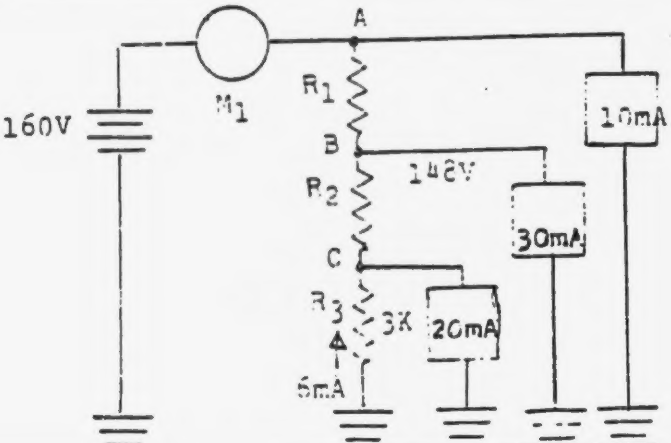
DATE________________________ ________________

1. Total current = ________
2. Voltage R_2 = ________
3. Current B to A = ________
4. Current point D = ________
5. Voltage B to A = ________
6. Voltage C to D = ________


15Ω
A
10Ω
30Ω
D
R1 90Ω
R3
R5
R6
R4
45Ω
30Ω
R2
120V
C
40Ω
B
180Ω
R8
R10
R11
50Ω
R7
50Ω
R9
180Ω

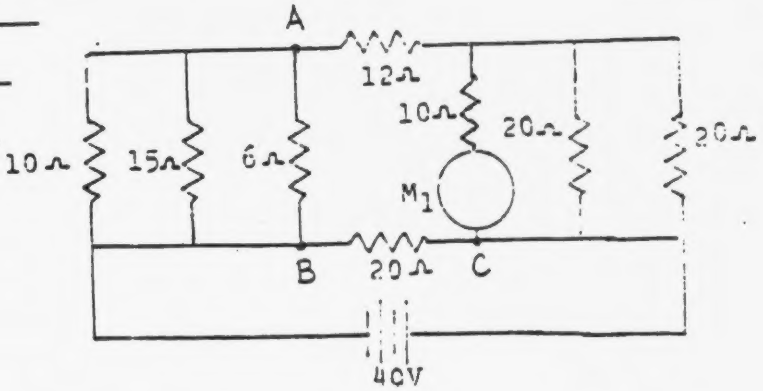
---

7. Voltage ground to C = ________
8. Current M_1 = ________
9. Current R_1 = ________
10. Current R_2 = ________
11. Resistance R_1 = ________
12. Resistance R_2 = ________
13. Total power = ________


A
160V
M1
R1
10mA
B
142V
R2
30mA
C
R3
3K
20mA
6mA

---

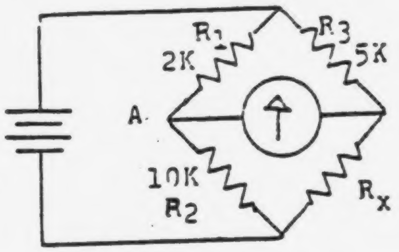
14. Voltage B to C = ________
15. Voltage B to A = ________
16. Resistance B to C = ________
17. Total current = ________
18. Current M_1 = ________


A
12Ω
10Ω
20Ω
20Ω
10Ω
15Ω
6Ω
M1
B
20Ω
C
40V

19. R_X = __________

20. Change R_3 to 3K ohms.
R_X = __________

21. Change R_2 to 5K ohms.
R_X = __________

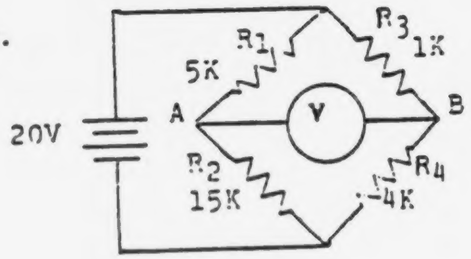

R1
2K
R3
5K
A
B
10K
R2
Rx

Note: Balance Bridge

---

22. Voltage A to B = __________

23. Change R_4 to a 3K ohms resistor.
Voltage A to B = __________


R1
5K
R3
1K
A
V
B
20V
R2
15K
R4
4K

PERSONAL COMPUTER TECHNICIAN TRAINING PROGRAM

MODULE #2

UNIT V - PRACTICE PROBLEMS - Series-Parallel Circuits (Handout #1)

1. Find:

R_T =

I_T =

V_{R_1} =

V_{R_2} =

V_{R_3} =

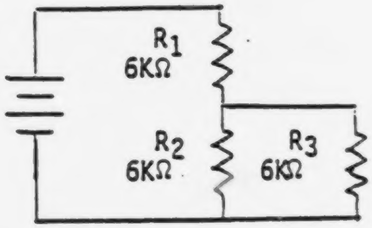
I_{R_1} =

I_{R_2} =

I_{R_3} =

P_T =

P_{R_3} =


18V
R1 6KΩ
R2 6KΩ
R3 6KΩ

---

2. Find:

R_T =

I_T =

V_{R_1} =

V_{R_2} =

V_{R_3} =

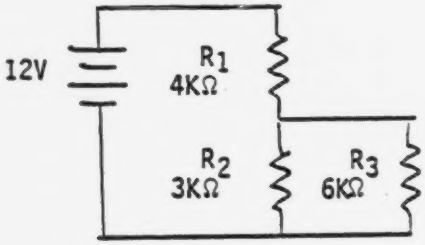
I_{R_1} =

I_{R_2} =

I_{R_3} =

P_T =

P_{R_1} =


12V
R1 4KΩ
R2 3KΩ
R3 6KΩ

---

3. Find:

R_T =

I_T =

I_{R_1} =

I_{R_2} =

I_{R_3} =

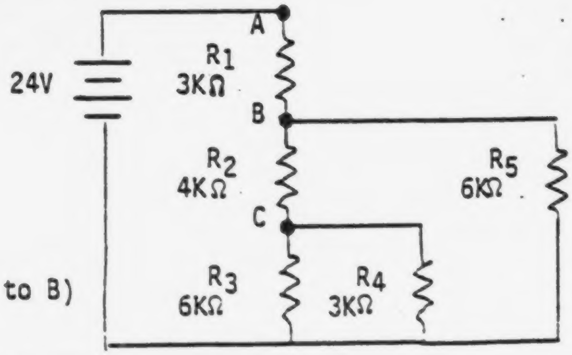
I_{R_4} =

I_{R_5} =

V_C =

V_B =

V_{BC} = (from C to B)


24V
A
R1 3KΩ
B
R2 4KΩ
C
R3 6KΩ
R4 3KΩ
R5 6KΩ

---

4. Find:

R_T =

I_T =

I_{R_1} =

I_{R_2} =

I_{R_3} =

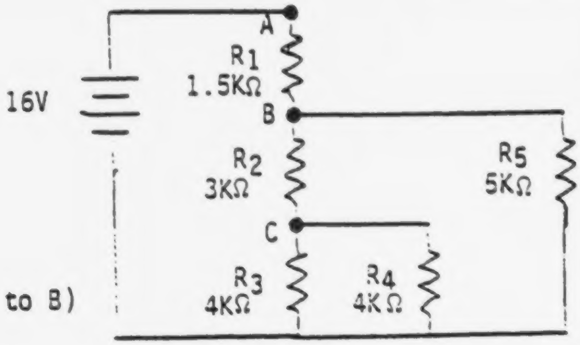
I_{R_4} =

I_{R_5} =

V_B =

V_C =

V_{BC} = (from C to B)


16V
A
R1 1.5KΩ
B
R2 3KΩ
C
R3 4KΩ
R4 4KΩ
R5 5KΩ

PERSONAL COMPUTER TECHNICIAN TRAINING PROGRAM

MODULE #2

UNIT V - PRACTICE PROBLEMS - Series-Parallel Circuits (Handout #1) continued

5. Find:

I_T =

I_{R_1} =

I_{R_2} =

I_{R_3} =

I_{R_4} =

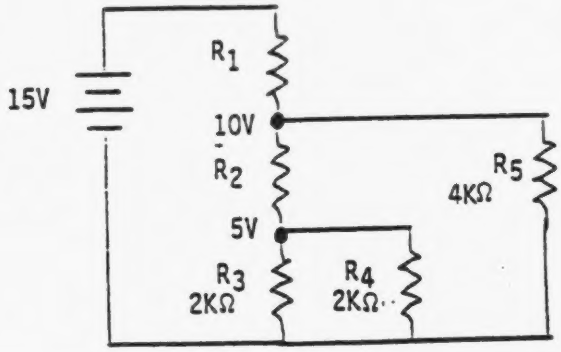
I_{R_5} =

V_{R_1} =

V_{R_2} =

V_{R_5} =

V_{R_4} =


15V
R1
10V
R2
5V
R3
2KΩ
R4
2KΩ
R5
4KΩ

---

6. Find:

I_T =

I_{R_1} =

I_{R_2} =

I_{R_3} =

I_{R_4} =

I_{R_5} =

V_{R_1} =

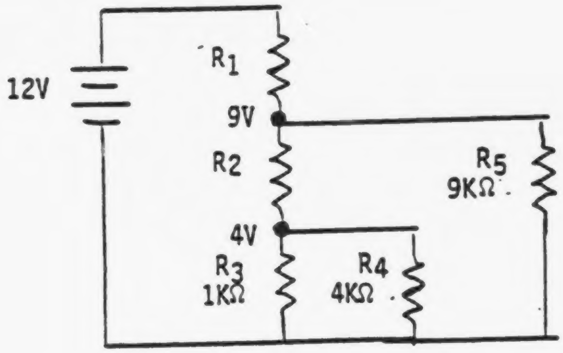
V_{R_2} =

V_{R_5} =

V_{R_4} =

R_1 =

R_2 =


12V
R1
9V
R2
4V
R3
1KΩ
R4
4KΩ
R5
9KΩ

EXPERIMENT

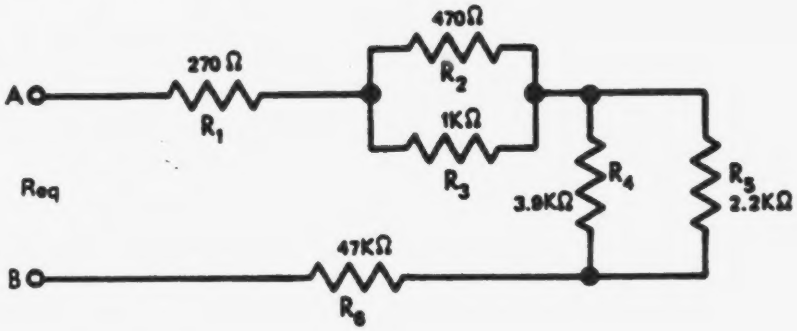
EXPERIMENT 1 - RESISTANCE IN SERIES-PARALLEL

MATERIALS:

Ohmmeter
100 Ω resistor
270 Ω resistor
470 Ω resistor
1 KΩ resistor
2.2 KΩ resistor
3.9 KΩ resistor
47 KΩ resistor

PROCEDURE:

1. Connect circuit as shown below:


470Ω
R2
270Ω
R1
A
1KΩ
R3
Req
R4
3.9KΩ
R5
2.2KΩ
47KΩ
R6
B

2. Using an ohmmeter measure the resistance (Req) across points A and B.

Measured R_{eq} ________________

3. Calculate the R_{eq} of the circuit. Calculated R_{eq} ________________

Experiment #1

4. Allowing for 10% error, your measured R_{eq} value should equal the calculated value. The results of this experiment should verify that any series-parallel circuit can be reduced to one total or equivalent resistance.

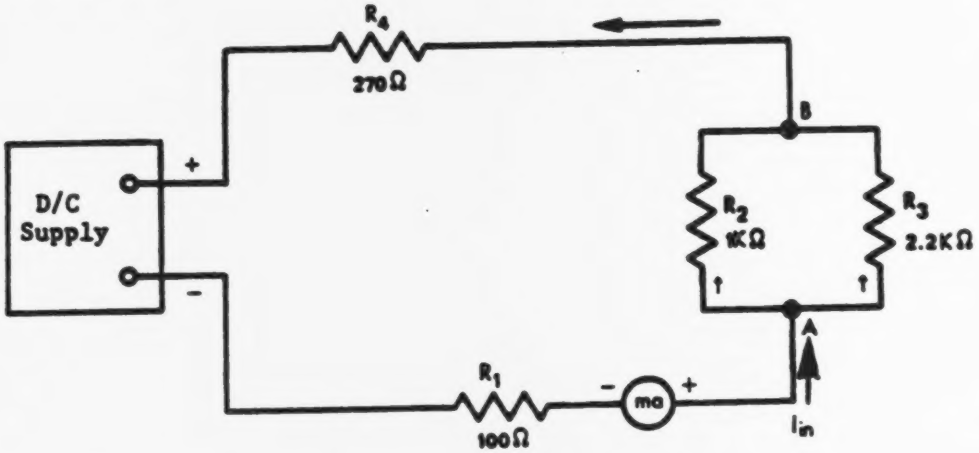
EXPERIMENT 2 - CURRENT IN SERIES-PARALLEL

MATERIALS:

DC power supply
Milliammeter
1 K Ω resistor
2.2 K resistor
100 Ω resistor
270 Ω resistor

PROCEDURE:

1. Connect circuit as shown:

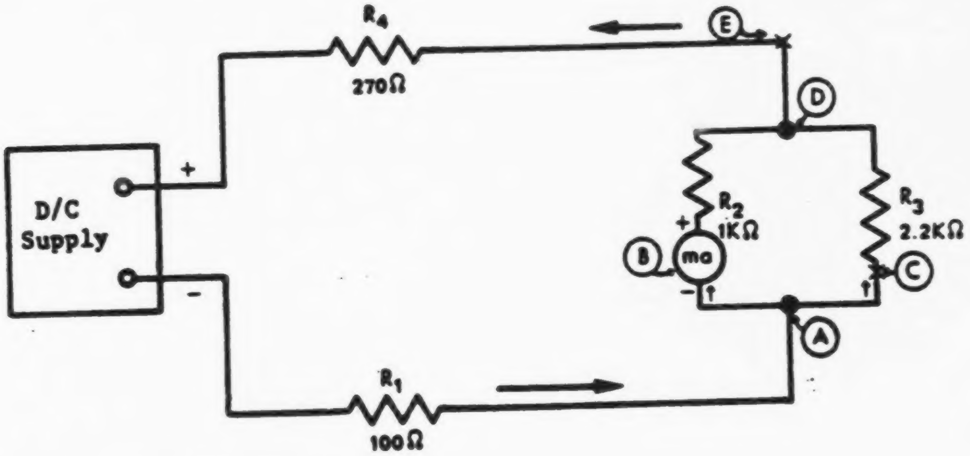

R4
270Ω
B
+
D/C Supply
−
R2
1KΩ
R3
2.2KΩ
R1
100Ω
−
ma
+
I_in

2. Adjust power supply to read 12 volts.

3. Measure current flowing into junction A. Record I_{in} ______________

Experiment #2 con't

4. Move milliammeter to point B as shown:



5. Adjust power supply to read 12 volts.

6. Measure current flowing in branch B. Record I_2 ____________________

7. Move milliammeter to point C (break cct at "x" and insert). Measure and record current

I_3 ____________________

8. Move millammeter to point E. Measure and record current flowing out of junction D.

Record I_{out} ____________________

9. Add branch currents I_2 and I_3 ____________________

10. Does the sum of I_2 and I_3 branch currents equal current flowing into junction A? (See step 3)

Experiment #2 con't

11. Does the sum of I_2 and I_3 branch currents equal current flowing out of junction D? (See step 8)

12. Results of this experiment should verify that current flowing into a junction equals current flowing out of that junction. (Allow 10% variation for error tolerance)

13. Is it possible to find current flow through R_1 without actually using a milliammeter? Explain how.

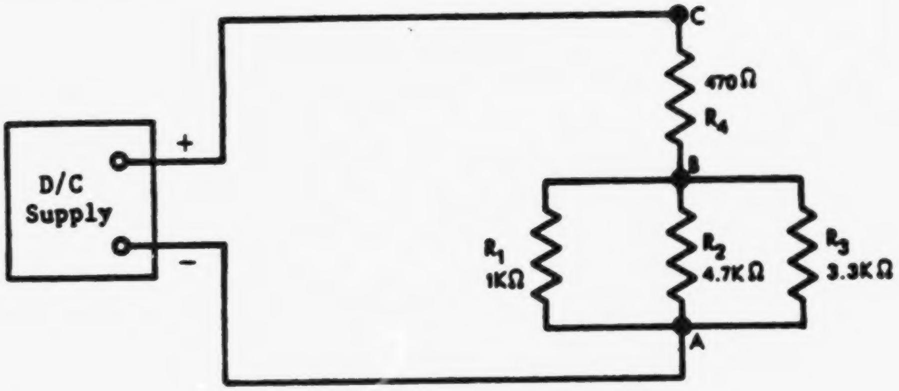
EXPERIMENT 3 - VOLTAGE IN SERIES-PARALLEL CIRCUITS

MATERIALS:

DC power supply
voltmeter
470 Ω resistor
1 K Ω resistor
4.7 K Ω resistor
3.3 K Ω resistor

PROCEDURE:

1. Connect circuit as shown:



2. Adjust power supply to read 15 VDC.
3. Measure voltage across points A and B. Record_______________volts
4. Measure voltage across points B and C. Record _______________volts
5. Measure voltage across points A and C. Record _______________volts
6. Add the voltages across points A and B, B and C. What does this equal?

____

Experiment #3

7. What can you say about the voltage across each leg of a parallel circuit?

8. Write an equation which would verify the voltage relationship in series-parallel of this experiment.

9. Using Ohm's Law and the voltage measurements taken in steps 3 and 4 calculate I_1 ____________________

I_2 ____________________

I_3 ____________________

I_4 ____________________

10. Using Ohm Law compute voltage drop across R_1 , $R2$, R_3 and R_4 as

E_1 ____________________

E_2 ____________________

E_3 ____________________

E_4 ____________________

Experiment #3

11. These computed values should verify the measured values taken in steps 3, 4, and 5.

SERIES-PARALLEL CIRCUITS

Lab Sheet #9

OBJECTIVES

To observe how series-parallel circuits operate
To practice wiring series-parallel circuits
To develop skills in wiring and testing series-parallel circuits
To develop skills in troubleshooting series-parallel circuits

MATERIALS REQUIRED

Decade Box
Solderless Breadboard
DMM
VTVM or VOM
Resistors (Parts Kit)
Precision Resistor Board

PROJECT 1: Calculating Total Resistance in a Series-parallel Circuit

INTRODUCTION

You should understand both series circuit and parallel circuit operation. Now you will combine the two and see how series-parallel circuits operate.

INSTRUCTIONS

1. Measure the resistance of these resistors.

R1 (2k)= _____ohms. R2 (4.7k)= _____ohms.

R3 (3.3k) = _____ohms.

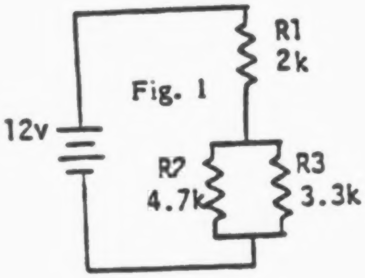


Fig. 1

2. Calculate the equivalent resistance of R2 in parallel with R3. Designate this "Req".

Req = __________ohms.

3. Calculate the circuit total resistance (R_T).

R_T = Req + R1 = _________ohms.

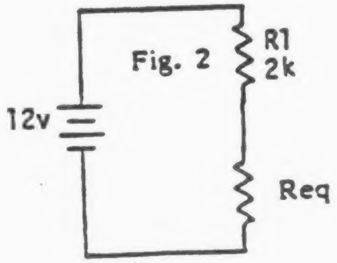


Fig. 2

4. Calculate the total current (I_T) flow from the power supply.

$$I_T = \frac{\text{Eapplied}}{R_T} = \text{\_\_\_\_\_\_ mA.}$$

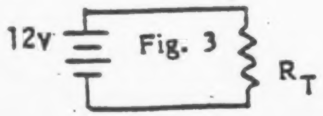


Fig. 3

5. Calculate the voltage across R1.

$E_{R1} = I_T \times R1 =$ ______volts.

6. Measure the voltage across R1.
Is it the same as in STEP 5? YES/NO

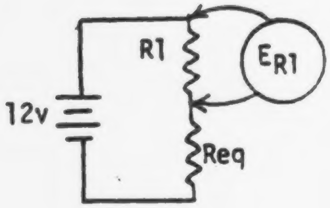


Fig 4

7. Calculate the current through R1.

$$I_{R1} = \frac{E_{R1}}{R1} =$$ ______mA.

8. Does the current calculated in STEP 7 equal the current calculated in STEP 4? YES/NO

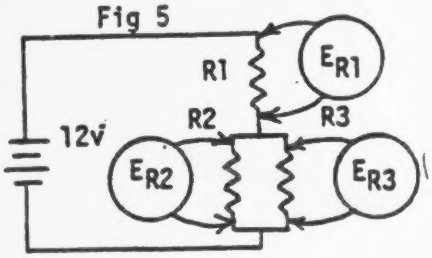
9. Measure I_T using the DMM milliammeter.

$I_T =$ ________mA. Is it as calculated? YES/NO

10. Calculate the voltage across R2 and R3 ($E_{R2,R3}$).

$E_{R2,R3} =$ Eapplied - $E_{R1} =$ _______volts.

Fig 5



11. Measure the voltage across R2 and R3.

$E_{R2} =$ ________volts = $E_{R3} =$ ________volts.

E_{R2} should equal E_{R3} since they are in parallel.

Is the voltage as calculated in STEP 10? YES/NO

Does $E_{R2} = E_{R3}$? YES/NO

12. Calculate the current through R2 and R3.

$$I_{R2} = \frac{E_{R2}}{R2} =$$ ______mA. $$I_{R3} = \frac{E_{R3}}{R3} =$$ _____mA.

13. Measure the current through R2 only. Record below.

Remember to put the milliammeter IN SERIES with only the resistor you are measuring and NOT ACROSS IT.

$I_{R2} =$ ________mA.

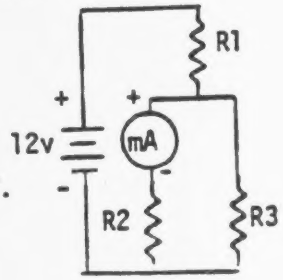


Fig 6

14. Measure the current through R3 only. Record.

I_{R3} = _______mA.

15. Is the measured current through R2 and R3 as calculated? YES/NO

Did you connect the ammeter properly? YES/NO

16. Calculate the power dissipated in each resistor, and the total power.

NOTE: You have several formulas you can use. All should produce close to the same answer, depending on accuracy of measurements.

P_{R1} = _____mW. P_{R2} = _____mW. P_{R3} = _____mW. P_T = _____mW.

SUMMARY

You should have observed these concepts about series-parallel circuits:

Resistors in parallel appear as an equivalent resistance and can be treated, in many cases, as one resistor.

Once all the equivalent resistances are found, the complex circuit can be treated as a series circuit for many calculations.

Each series resistor passes the total current in the circuit. Therefore, total current can be found in any circuit by using a voltmeter and a simple calculation. This is often more practical than opening the circuit to use a milliammeter.

PROJECT 2: More Practice Working with Series-parallel Circuits

INTRODUCTION

This project will give you an opportunity to use a different approach in analyzing a series-parallel circuit. You should recognize that you now have many tools with which to solve series-parallel circuit problems.

INSTRUCTIONS

1. Connect the circuit shown and turn the power "on".

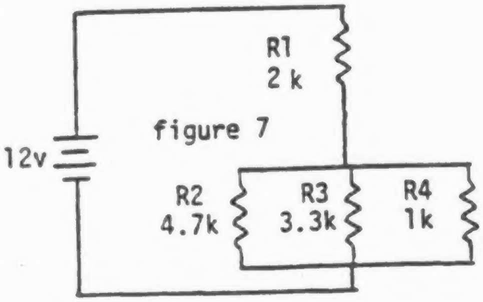
2. Measure the voltage across each resistor.

E_{R1} = _______volts.

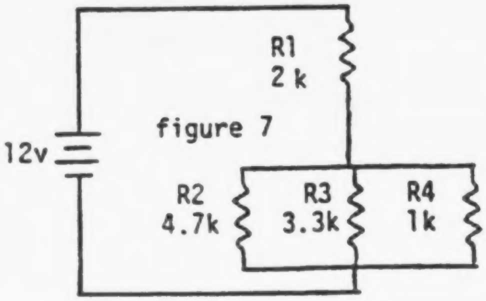
E_{R2} = _______volts.

E_{R3} = _______volts.

E_{R4} = _______volts.



3. Calculate the current in each resistor.



I_{R1} = _______mA.

I_{R2} = _______mA.

I_{R3} = _______mA.

I_{R4} = _______mA.

4. Calculate total current.

I_T = _______ma.

5. Calculate total resistance:

$$R_T = \frac{E_{applied}}{I_T}$$

6. Calculate equivalent resistance of R2, R3, R4 (Req) in these three ways:

$$Req = \frac{1}{1/R2 + 1/R3 + 1/R4} = \_\_\_\_\_\_\_\_\_ \text{kohms.}$$

$$Req = R_T - R1 = \_\_\_\_\_\_\_\_\_ \text{kohms.}$$

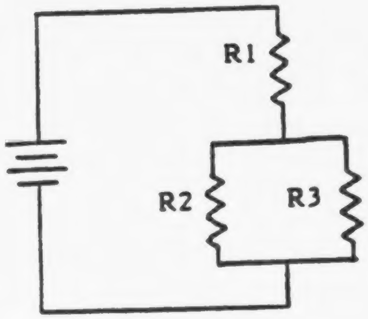
$$Req = \frac{E_{R2,R3,R4}}{I_T} = \_\_\_\_\_\_\_\_\_ \text{kohms.}$$

7. Disconnect the power supply and measure the total resistance of the circuit with the ohmmeter. R_T = ____________kohms.

8. Using as many formulas as you know, calculate the power in each resistor. Show the formulas and answers below.

SUMMARY

If you are to be an outstanding electronics technician, you must be completely familiar with all aspects of series-parallel circuits. Below is a summary of some main mathematical relationships in series-parallel circuits.



$$R_T = \frac{E_{applied}}{I_T}$$

$$R_T = R1 + Req$$

$$Req = \frac{1}{1/R2 + 1/R3}$$

$$E_{Req} = I_T \times Req$$

$$E_{Req} = \frac{Req}{R_T} \times E_{applied}$$

$$E_{R1} = \frac{R1}{R_T} \times E_{applied}$$

$$I_{Req} = \frac{E_{Req}}{Req}$$

$$I_{R1} = \frac{E_{R1}}{R1}$$

$$I_{R2} = \frac{E_{R2}}{R2}$$

$$I_{R3} = \frac{E_{R3}}{R3}$$

$P_T = E_{applied} \times I_T$ or $P_T = P_{R1} + P_{R2} + P_{R3}$

PROJECT 3: The Resistance Bridge Circuit (An Application of Series-parallel Circuits.)

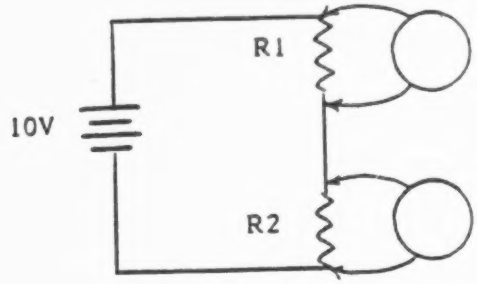
INTRODUCTION

The resistance bridge circuit has long been one of the most useful and accurate means of measuring resistance. The circuit with its resistors, switches, batteries, and a voltmeter usually are encased in a box. This useful "box" is called a "Wheatstone Bridge", after Sir Charles Wheatstone (1802-1875).

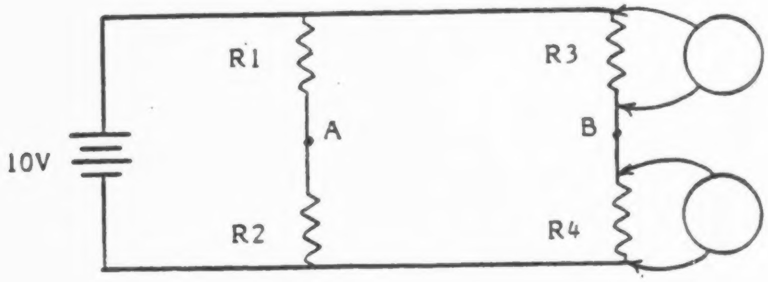
The principle of the BRIDGE CIRCUIT is simple and important to understand, for it has many applications in electronics test equipment. Be sure to read about the Wheatstone Bridge in your text before doing this Project.

INSTRUCTIONS

1. Select two identical value resistors on the Precision Resistor Board of any value. Connect them as shown and measure the voltage across each. Enter the voltage on the schematic in the "meters".



2. Select two other identical value resistors on the Precision Resistor Board and connect them to the first two, as shown. Measure the voltage and record in the "meters".



3. Measure the voltage between points "A" and "B". If the value of R1 = R2 and R3 = R4, you should measure 0.00 volts.

SUMMARY

Now you might wonder why anyone remembers Charles for inventing this circuit that measures 0 volts. Here is why: If there are 0 volts between "A" and "B", then there exists a mathematical relationship between the four resistors like this:

$$\frac{R1}{R2} = \frac{R3}{R4}$$

With this concept, we can use two matched resistors and one precision variable resistor (such as the Decade Box) to determine the value of any unknown fourth resistor. This was a neat trick in Charles' day before ohmmeters were in wide use. It is still a neat trick. However, instead of using only matched resistors, we can use matched capacitors or coils to measure unknown capacitors or coils. And that is something an ohmmeter can't do!

PROJECT 4: Using the BRIDGE CIRCUIT to Determine an Unknown Resistance

INTRODUCTION

You will now use the balanced bridge principle to determine the resistance of an unknown resistor. (Actually, you will be able to see the color code, but don't let that influence you while you do the Project.) Again, the principle can be stated mathematically like this:

Zero volts between "A" and "B" when $\frac{R1}{R2} = \frac{R3}{R4}$

So if R1 and R2 are ANY known value resistors, and R4 is a Decade Box, then all we need to determine the value of R3 is: (1) To adjust the Decade Box until the voltmeter reads 0 volts. (2) To determine R3 resistance using the below mathematical relationship this way:

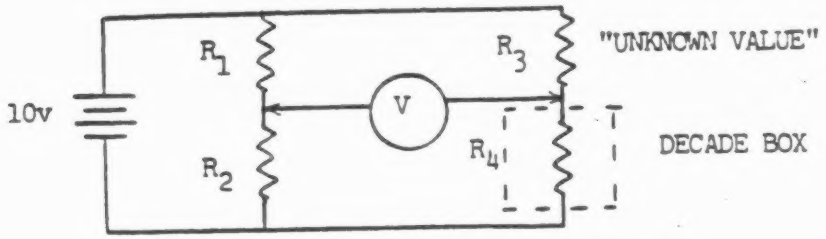
(* Known value resistors.) $\frac{*R1}{*R2} = \frac{R3}{*R4} = \frac{*R4 \times *R1}{*R2} = R3$

INSTRUCTIONS

1. Select ANY two known value resistors and connect them as R1 and R2 below. The two resistors do not need to be the same value.

R1:________ohms.

R2:________ohms.



2. Select any unknown value resistor for R3 and connect it in the circuit with the Decade Box (R4) as shown in STEP 1.

3. With minimal instructions now, go ahead and use the Bridge Circuit to measure some resistors from your Parts Kit. For the voltmeter, first use the VTVM, then try the DMM to see which type you prefer. Use the Zero Center feature of the VTVM which you learned in a previous Lab Sheet. Set the VTVM RANGE selector for 50 volts and, once the circuit is balanced, lower the RANGE selector for more accurate balancing. Be sure not to "peg" the needle on the low ranges by making any big change in the Decade Box resistance.

NOTE: Each lab bench partner should do the STEP 3 procedure. It is an excellent exercise to develop and practice the "delicate touch", another skill necessary for a good electronics technician.

4. After you have used the balanced bridge technique in STEP 3 to determine the value of the "unknown" resistor, measure the resistance value using the DMM ohmmeter and record below in the top line. Practice with as many resistors as you need, until you feel comfortable with this technique.

NOTE: In order to stay within the range of the decade box, make a bridge with R1 and R2 equal in value. Also do not attempt to measure an unknown resistor less than 100 ohms. This will save you some possible problems.

Unknown Resistor Color Coded Resistance	R3 Measured Resistance using Bridge Circuit	R3 Measured Resistance using the DMM Ohmmeter
__________ ohms	__________ ohms	__________ ohms
__________ ohms	__________ ohms	__________ ohms
__________ ohms	__________ ohms	__________ ohms
__________ ohms	__________ ohms	__________ ohms
__________ ohms	__________ ohms	__________ ohms
__________ ohms	__________ ohms	__________ ohms
__________ ohms	__________ ohms	__________ ohms
__________ ohms	__________ ohms	__________ ohms
__________ ohms	__________ ohms	__________ ohms
__________ ohms	__________ ohms	__________ ohms

SUMMARY

You should have observed how the resistance balanced bridge circuit can be used to find the value of an unknown resistor. This is a very important principle used widely in electronics.

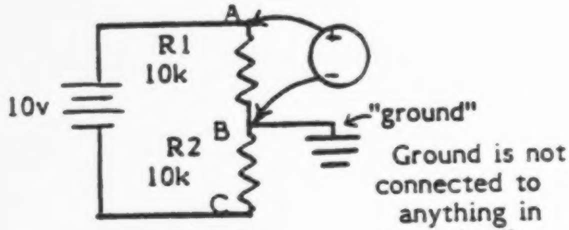
PROJECT 5: Voltage Reference Points in a Circuit

INTRODUCTION

You should be familiar with the symbol designating the "ground" point in a circuit. In this Project, you will see this reference "ground" point moved to different locations in order to provide both "+" and "-" voltages.

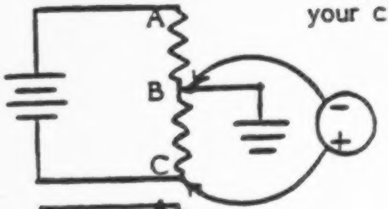
INSTRUCTIONS

1. Connect R1 and R2 as shown.



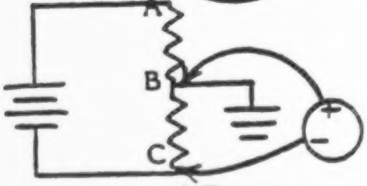
2. Measure the voltage from B to A. This means the voltmeter "common" lead is on "B", and the "+" lead is on "A". Record the polarity and voltage.

Volts "B" to "A": ______volts.
(Approximately + 5 volts)



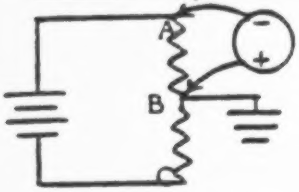
3. Similarly, measure from "B" to "C". "B" is still the reference point.

Volts "B" to "C": ______volts.
(Approximately - 5 volts)



4. Now reverse the voltmeter leads and measure from "C" to "B". The "common" lead is now on "C". Record.

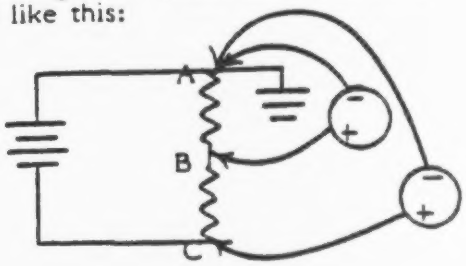
Volts "C" to "B": ______volts.
(Approximately + 5 volts)



5. Similarly, measure from "A" to "B". "A" is now the reference point.

Volts "A" to "B": ______volts.
(Approximately - 5 volts)

6. Now if we make "A" the "ground" point in the circuit, it will be schematically represented like this:



Point "B" is now - 5 volts in relation to the reference "ground" ("A"). Point "C" is - 10 volts in relation to the reference "ground" ("A").

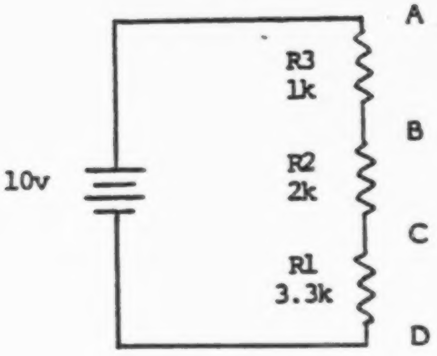
7. If you understood the STEP 1 through 6 concepts, continue with STEP 8.

8. Before connecting this circuit, calculate the voltage drop across each resistor.

E_{R1}: _____volts.

E_{R2}: _____volts.

E_{R3}: _____volts.



9. If you make the reference "ground" at different points, you will get different polarity voltages at each point.
Use the chart below to set the different reference points and to record the polarity and voltage from each output. Write the calculated value above the slash line and the measured value below, as shown in the example at the right.
Go ahead and connect the circuit, apply power, and make all the indicated measurements.

Be sure you understand the concept of the reference "ground" point before going to the next Project.

EXAMPLE:

+7.5v / +7.4v

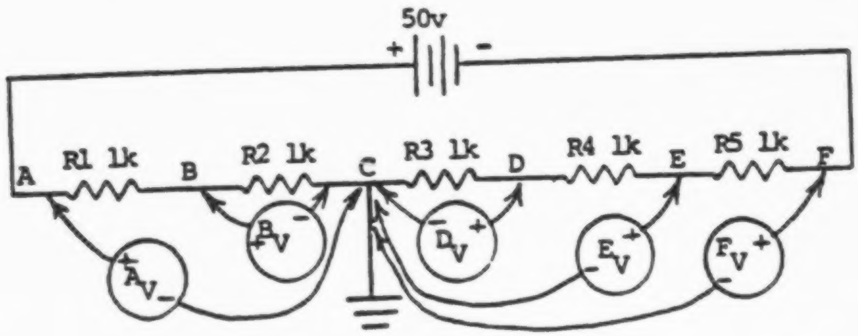
VOLTAGE AT TEST POINT BELOW	WITH GROUND REFERENCE AT POINT			
	D	C	B	A
A				0
B			0	
C		0		
D	0			

PROJECT 6: Self Evaluation Quiz

INSTRUCTIONS

Select the best answer for each question. (Answers are on last page.)

The below schematic is for questions 1 through 6.



1. The voltage indicated by meter F_V is ______volts.

   a. 10 b. 30 c. -30 d. 40 e. 50

2. The voltage indicated by meter B_V is ______volts.

   a. 10 b. 20 c. 30 d. 40 e. 50

3. The polarity of E in reference to C is _________.

   a. positive b. negative c. black d. red e. up

4. The polarity of B in reference to C is _________.

   a. positive b. negative c. black d. red e. up

5. The polarity and voltage of E in reference to B is _______.

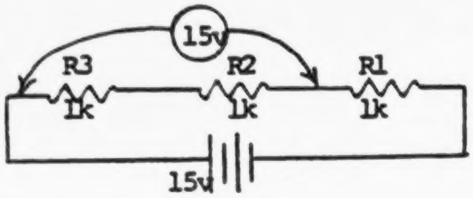
   a. +30 b. -30 c. +20 d. -20 e. +10

6. Point C is "shorted" to point D with a clip lead. The voltage at E in reference to C is ________volts.

   a. -10 b. -20 c. -30 d. -40 e. -12.5

Identify the faulty component in the circuits below.

7. What is the trouble?


15v
R3
1k
R2
1k
R1
1k
15v

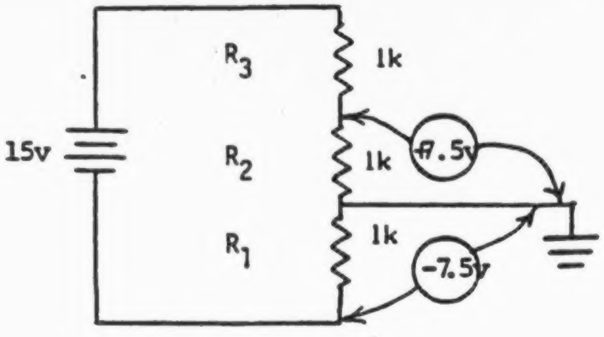
a. R1 open

b. R1 shorted

c. R2 shorted

d. R3 shorted

8. What is the trouble?


R3
1k
15v
R2
1k
+7.5v
R1
1k
-7.5v

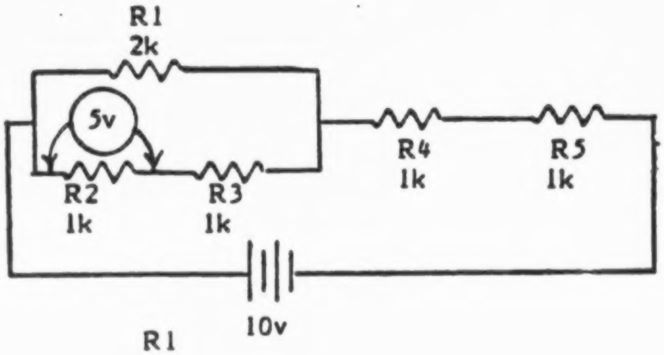
a. R1 open

b. R2 open

c. R3 open

d. R3 shorted

9. What is the trouble?


R1
2k
5v
R2
1k
R3
1k
R4
1k
R5
1k
10v

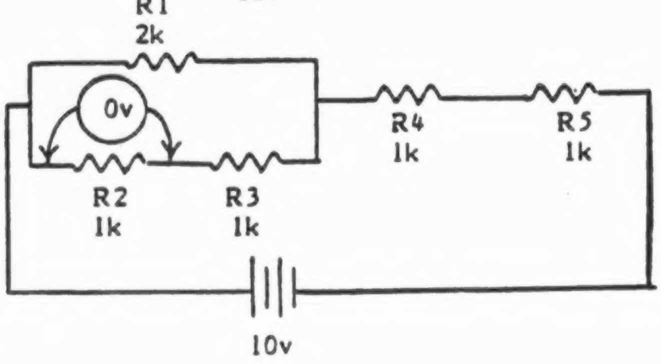
a. R1 open

b. R2 open

c. R3 open

d. R3 shorted

10. What is the trouble?


R1
2k
0v
R2
1k
R3
1k
R4
1k
R5
1k
10v

a. R5 shorted

b. R1 open

c. R3 shorted

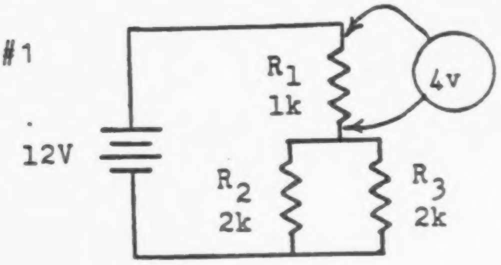
d. R3 open

PROJECT 7: QUIZ: Troubleshooting Series-parallel Circuits

INSTRUCTIONS

Each schematic below shows how the circuit should be wired. However, each circuit has either a "shorted" or an "open" resistor. Study the meter indications and determine where the "trouble" is in the circuit. Select the most correct response. Record your response on an answer form and turn it in to your instructor at the next lab period. Do not connect these circuits to test them. Work on these questions outside of the lab period.

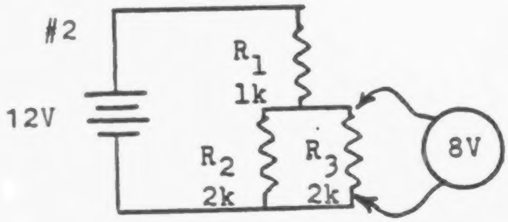
#1



R1
1k
4v
12V
R2
2k
R3
2k

a. R_1 open
b. R_2 open
c. R_1 shorted
d. R_3 shorted

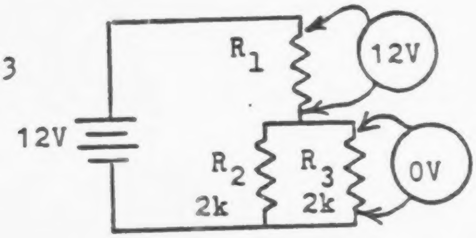
#2



R1
1k
12V
R2
2k
R3
2k
8V

a. R_1 open
b. R_1 shorted
c. R_3 open
d. R_3 shorted

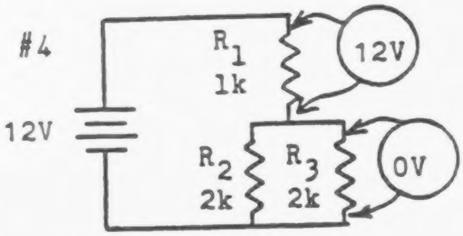
#3



R1
12V
12V
R2
2k
R3
2k
0V

a. R_1 shorted
b. R_2 shorted
c. R_2 open
d. R_3 open

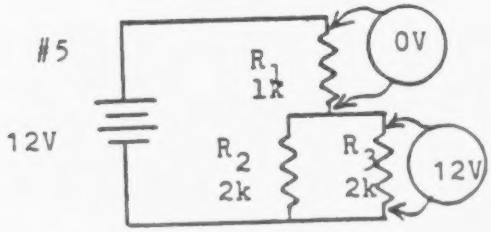
#4



R1
1k
12V
12V
R2
2k
R3
2k
0V

a. R_1 open
b. R_2 open
c. R_3 open
d. R_1 shorted

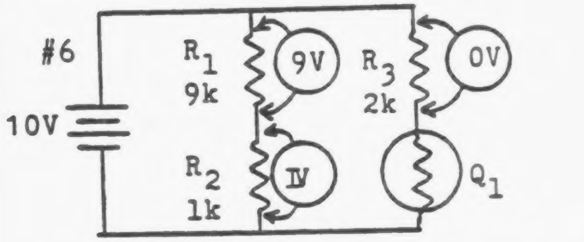
#5



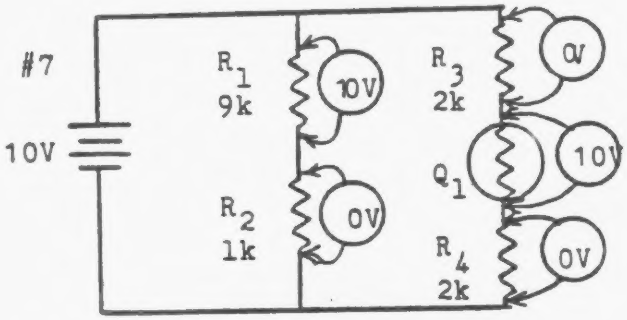
R1
1k
0V
12V
R2
2k
R3
2k
12V

a. R_1 open   b. R_2 open   c. R_3 open   d. R_1 shorted

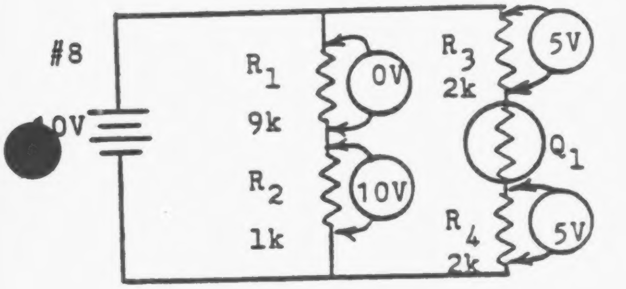
Questions 6 through 10 are simple series-parallel circuits with a special resistive device designated "Q_1". Treat Q_1 like it was a resistor. This exercise is much like troubleshooting a transistor amplifier circuit. Use what you know about series-parallel resistor circuits to select the best response below each schematic. Note: Some circuits have one faulty component and some have two.


#6
10V
R1
9k
9V
R2
1k
1V
R3
2k
0V
Q1

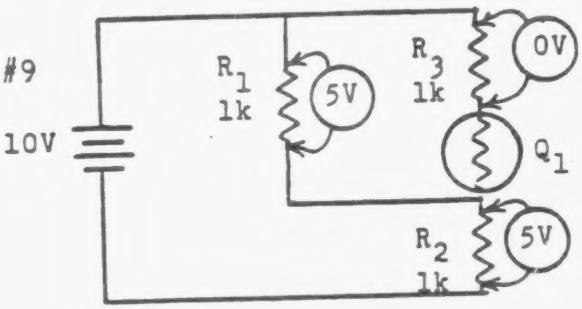
a. Q_1 open b. Q_1 shorted


#7
10V
R1
9k
10V
R2
1k
0V
R3
2k
0V
Q1
10V
R4
2k
0V

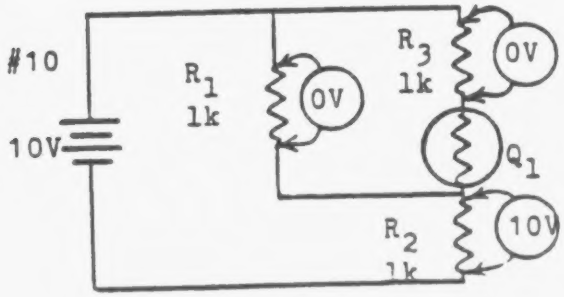
a. R_2 shorted & Q_1 shorted.
b. R_1 open & Q_1 shorted.
c. R_1 open & R_3 shorted.
d. R_1 open & Q_1 open.


#8
10V
R1
9k
0V
R2
1k
10V
R3
2k
5V
Q1
R4
2k
5V

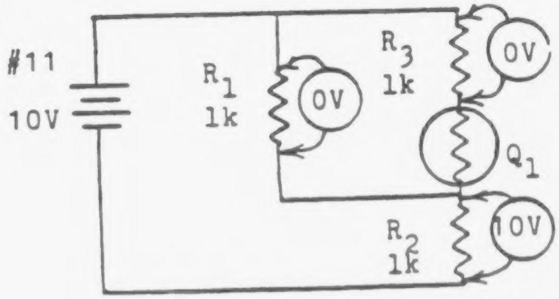
a. R_2 open & Q_1 open.
b. R_2 shorted & Q_1 shorted.
c. R_2 open & Q_1 shorted.


#9
10V
R1
1k
5V
R3
1k
0V
Q1
R2
1k
5V

a. Q_1 open b. Q_1 shorted

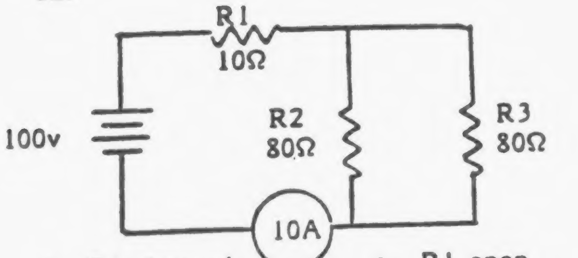

#10
10V
R1
1k
0V
R3
1k
0V
Q1
R2
1k
10V

a. R_1 open
b. R_3 shorted
c. R_3 open
d. R_2 open


#11
10V
R1
1k
0V
R3
1k
0V
Q1
R2
1k
10V

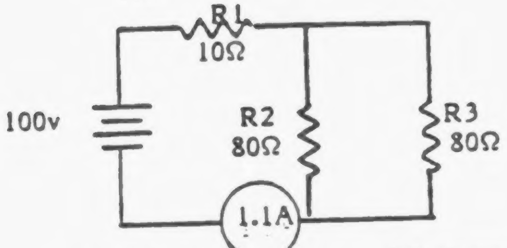
a. R_1 shorted
b. R_2 shorted
c. R_3 shorted
d. Q_1 shorted

12.


R1
10Ω
100v
R2
80Ω
R3
80Ω
10A

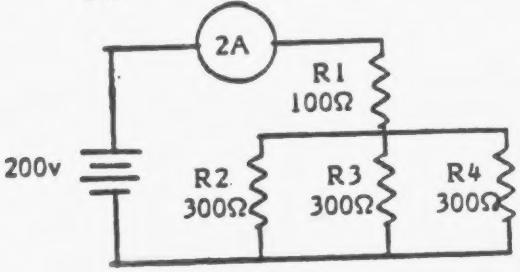
a. R1 shorted.
c. R1 open.
b. R2 open.
d. R2 shorted.

13.


R1
10Ω
100v
R2
80Ω
R3
80Ω
1.1A

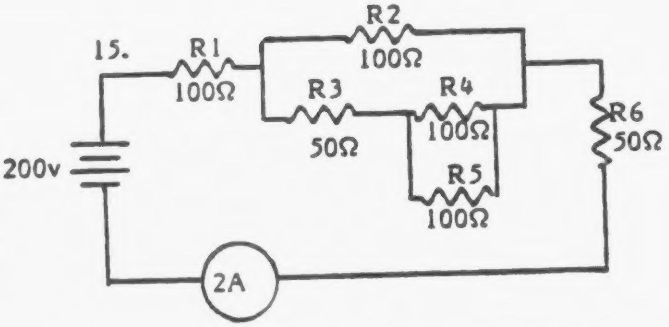
a. R1 open.
c. R2 shorted.
b. R2 open.
d. R3 shorted.

14.


2A
R1
100Ω
200v
R2
300Ω
R3
300Ω
R4
300Ω

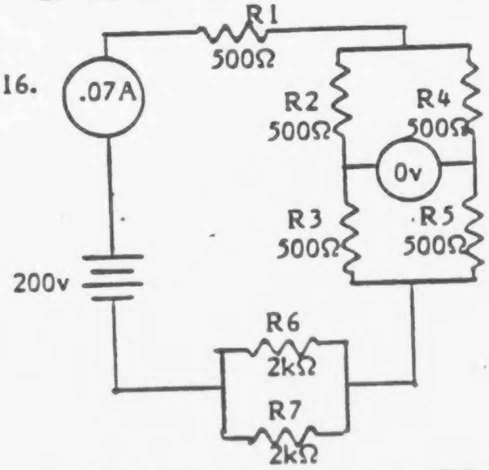
a. R1 open.
c. R2 open.
b. R2 shorted.
d. R3 open.

15.


R1
100Ω
R2
100Ω
R3
50Ω
R4
100Ω
R5
100Ω
R6
50Ω
200v
2A

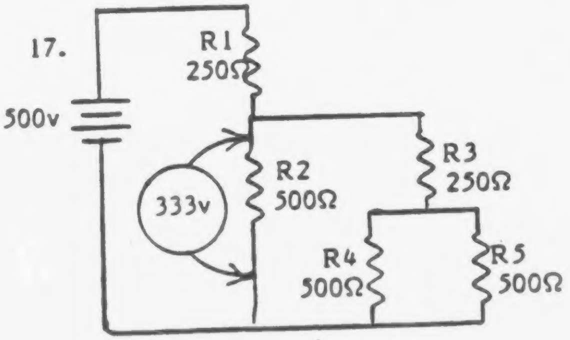
a. R1 shorted.
c. R4 shorted.
b. R2 open.
d. R6 shorted.

16.


R1
500Ω
.07A
R2
500Ω
R4
500Ω
0v
R3
500Ω
R5
500Ω
200v
R6
2kΩ
R7
2kΩ

a. R1 shorted.
c. R6 open.
b. R2 shorted.
d. R7 shorted.

17.


R1
250Ω
500v
333v
R2
500Ω
R3
250Ω
R4
500Ω
R5
500Ω

a. R3 open.
c. R4 open.
b. R3 shorted.
d. R5 shorted.

Answers to PROJECT 6: Self Evaluation Quiz

1 c, 2 a, 3 b, 4 a, 5 b,
6 e, 7 b, 8 d, 9 b, 10 d

VOLTAGE DIVIDERS (Unloaded)

Lab Sheet #10

OBJECTIVES

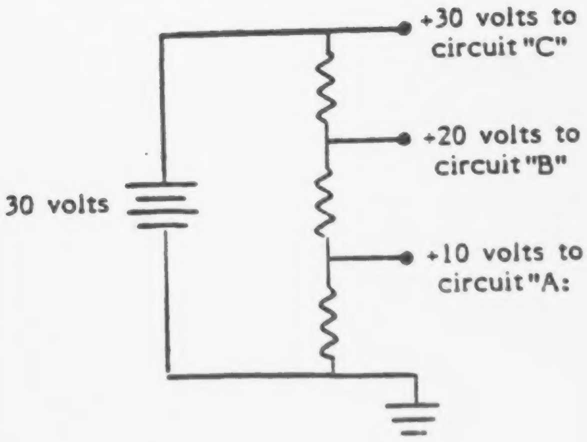
To learn how to test and measure unloaded voltage dividers
To learn how to test a voltage divider with "-" and "+" voltage
To develop skill in troubleshooting voltage divider circuits

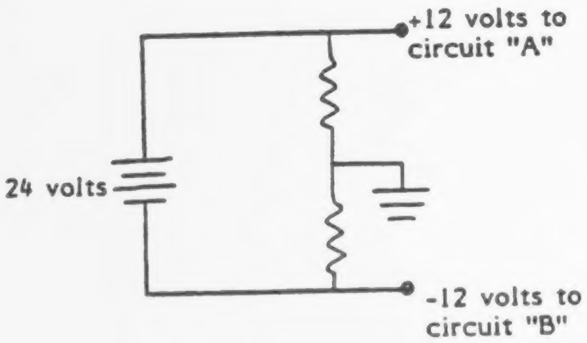
MATERIALS

DMM
Solderless Breadboard
Potentiometer: 1kohm
Resistors: 3.3k, 4.7k, (2) 10k, 15k

INTRODUCTION

A voltage divider is a series circuit with extra leads to provide two or more output voltages for other circuits. Some examples of voltage dividers are shown below.


+30 volts to
circuit "C"
+20 volts to
circuit "B"
30 volts
+10 volts to
circuit "A:


+12 volts to
circuit "A"
24 volts
-12 volts to
circuit "B"

(All resistors are equal value)

In this Lab Sheet, you will be working with UNLOADED VOLTAGE DIVIDERS. An unloaded Voltage Divider provides output voltages to circuits which do not draw current from the voltage divider. These circuits do not act as a "load" on the voltage divider. In the next Lab Sheet, you will work with LOADED VOLTAGE DIVIDERS. A loaded Voltage Divider must provide voltage and current to external circuits, or "loads".

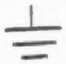
There are several very important voltage divider concepts which you will soon understand. They are essential to the operation of most electronic circuits. Therefore, considerable emphasis is being placed on understanding voltage dividers through numerous Projects.

You may recognize the unloaded voltage divider circuit immediately. It is a series circuit with voltage output points. Actually, you will seldom see an unloaded voltage divider, because most attached circuits pass significant current. However, to insure that you understand loaded voltage dividers, this Lab Sheet will cover the fundamental concepts of unloaded voltage dividers first. Some of the tasks in this Lab Sheet may be unnecessary for you to do if you understand series circuits completely. Work your way through this Lab Sheet rapidly, but don't miss any new information. The study of loaded voltage dividers is more important and deserves more time.

PROJECT 1: Unloaded Voltage Divider Current, Voltage, and Power

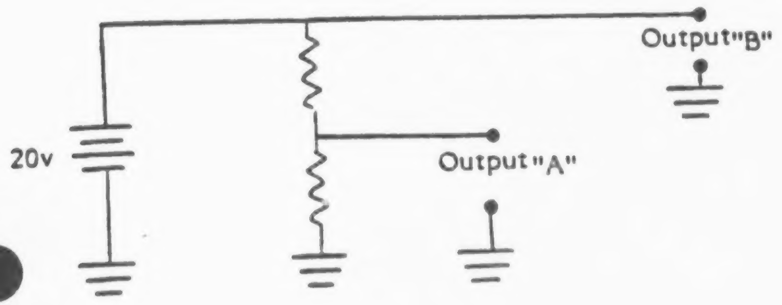
INTRODUCTION

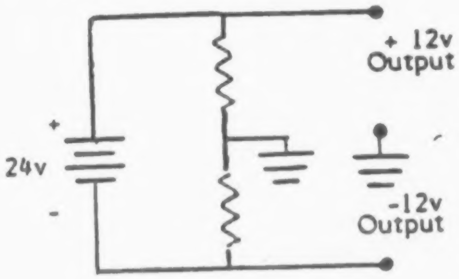
Voltage dividers usually have only one reference point for all voltage outputs. This point is where you place the voltmeter "common" or "-" lead. The other voltmeter lead ("+") can then measure the voltage at all the other output points IN RELATION TO THE "REFERENCE POINT". This reference point is called "GROUND" and on a schematic is represented by this symbol:



The "ground" point is not necessarily connected to anything. Sometimes it is connected to the equipment metal chassis (or a metal strip on a printed circuit board). In the automobile the metal frame and engine are the "ground". In this example the automobile frame serves as the conductor for the "-" side of the circuit. The metal chassis serves as the "-" side of the circuit in some electronic equipment. When this is done, it prevents having to run two wires to each operating device. Only a "+" lead needs to be run; the frame serves as the "-" lead.

Some examples of how these could be represented on schematics are shown below.

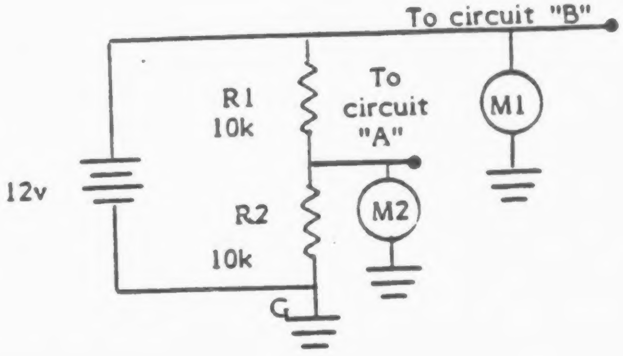




INSTRUCTIONS

1. Study the unloaded voltage divider below, and calculate the voltages which voltmeters M1 and M2 should indicate.

NOTE: Points A and B would go to two circuits requiring these two different specific voltages. Point G is the reference point for both circuits A and B.



Output voltage to Circuit B:

M1: ________volts

Output voltage to Circuit A:

M2: ________volts

2. Calculate the current flow in R1, R2, and total current.

I_{R1}: ________mA

I_{R2}: ________mA

3. Calculate the power dissipated in R1, R2, and the total power. (You have 3 formulas. All should give the same approximate answer.)

P_{R1}: _____mW

P_{R2}: _____mW

P_T: _____mW

4. If you calculated the answers shown below, go to PROJECT 2. If not, connect the above circuit and experiment with it until you understand it.

Answers to PROJECT 1:

M1: 12 volts. (Since this is connected directly to the power source, it must be the same voltage as the power source -- even without R1 and R2 there!)

M2: 6 volts. (Since R1 and R2 are equal value resistance, the voltage across each will be equal.)

I_{R1}: .6 mA	P_{R1}: 3.6 mW or .0036 watts.
I_{R2}: .6 mA	P_{R2}: 3.6 mW or .0036 watts.
I_T: .6 mA	P_T: 7.2 mW or .0072 watts.

PROJECT 2: Unloaded Voltage Divider Practice

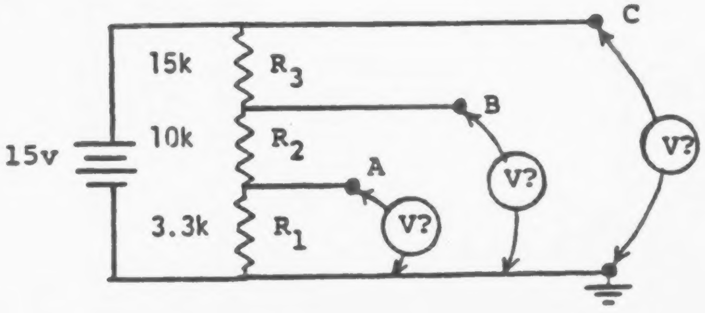
INSTRUCTIONS

1. Locate and measure the resistance of these resistors which you will be using later:

Color Coded Value	Measured Resistance	Circuit Designation
3.3kohms	___________	R1
10kohms	___________	R2
15kohms	___________	R3

2. Study the voltage divider below and calculate the indicated values. Use the measured resistance.

Notice that this voltage divider has output voltages for three different circuits. We are assuming Circuits A, B, and C do not have any current flowing in them.



I_T: ______mA

Output A: __________volts.

Output B: __________volts.

Output C: __________volts.

HINTS:

Start by finding the total resistance and then the total current. Finally, find the voltage drop across each resistor. Output A is simply the voltage drop across R1. Output B is the voltage drop across R2 PLUS THE DROP ACROSS R1. Output C is the voltage applied, which should be also equal to the sum of all the voltage drops across R1, R2, and R3.

You could also calculate the output voltages using the proportion formula. Try it.

Output A = $\frac{R1}{R_T} \times E_{APP}$ = ____________volts

Output B = $\frac{R1 + R2}{R_T} \times E_{APP}$ = ____________volts

Output C = $\frac{R1 + R2 + R3}{R_T} \times E_{APP}$ = ________volts

3. If you feel comfortable doing the calculations above, connect the circuit and make the voltage measurements. No leads need to go anywhere for Output A, B, and C; just check the voltage at these points. Record below.

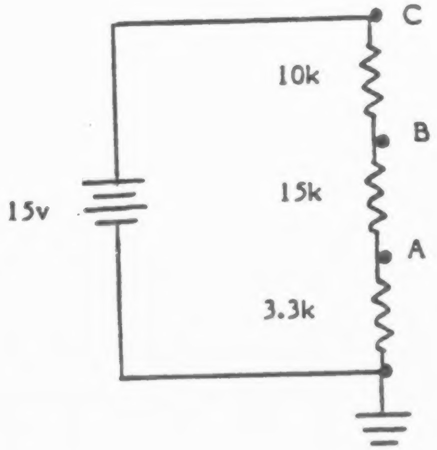
Output A: __________volts.

Output B: __________volts.

Output C: __________volts.

4. Are your measurements close to your calculations? YES/NO

5. Disconnect the circuit and reconnect it as shown below.



6. Calculate output voltages now.

Output A: __________volts.

Output B: __________volts.

Output C: __________volts.

7. Measure the output voltage.

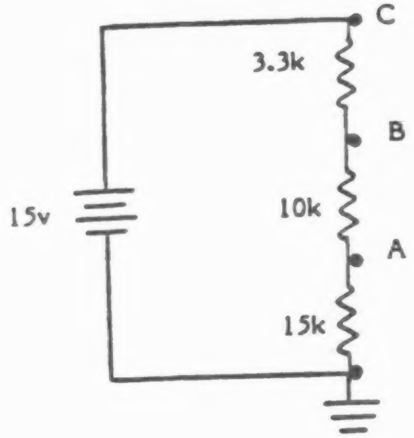
Output A: __________volts.

Output B: __________volts.

Output C: __________volts.

8. Are the measured voltages close to the calculated voltages? YES/NO

9. Disconnect the circuit and reconnect it as shown below.



10. Calculate output voltages now.

Output A: __________volts.

Output B: __________volts.

Output C: __________volts.

11. Measure the output voltage.

Output A: __________volts.

Output B: __________volts.

Output C: __________volts.

12. Are the measured voltages close to the calculated voltages? YES/NO

You have connected the same three resistors in series in three different voltage divider circuits. Can you make the necessary calculations to correctly answer these questions?

a. Was the power dissipated in R1, R2, and R3 the same in the different voltage divider circuits? YES/NO

b. Was the total power the same in the different voltage divider circuits? YES/NO

c. Was the current the same in the different voltage divider circuits? YES/NO

d. What, if anything, was different in the different voltage divider circuits?

voltages current power smoke

PROJECT 3: A Voltage Divider with a Variable Output Voltage

INTRODUCTION

The following simple circuit is often used in electronic equipment. One example is the volume control on a radio, TV, or Hi Fi.

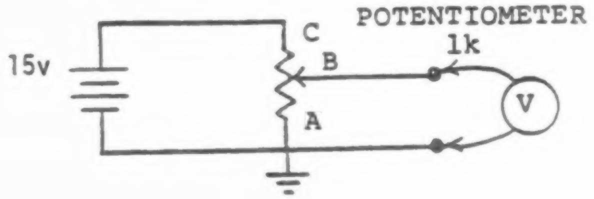
INSTRUCTIONS

1. Locate and measure the resistance of a 1kohm potentiometer on the "Pot Board".

Pot. resistance: _________ohms

2. Adjust the power supply for exactly 15 volts output using the DMM.

3. Connect the circuit below. Be very careful. Do not connect terminal "B" to anything except the DMM voltmeter. You should have only one pair of banana leads and the voltmeter connected to the potentiometer.



4. Apply power and adjust the "pot" to indicate 7.5 volts on the DMM. This is one-half of the applied voltage.

5. Turn off the power and remove the potentiometer without changing the adjustment.

6. Measure the resistance of the potentiometer between the center and each end. Record.

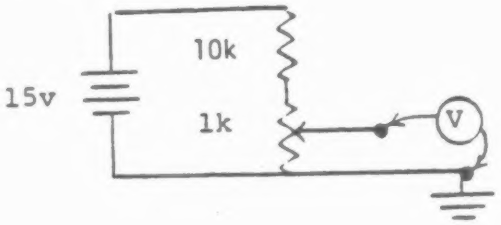
R_{AB}: _______ohms. R_{BC}: _______ohms.

7. Were the two resistances equal? YES/NO

8. Reconnect the potentiometer to the power supply and apply 15 volts.

9. Try to adjust the "pot" for exactly 1.00 volt. It may be difficult, and that is the purpose of this step: to see how difficult it is. Go to STEP 10.

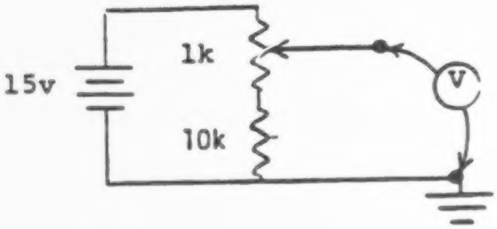
10. Connect a 10kohm resistor in the circuit as shown. This will make the 1.00 volt adjustment easier.



11. Apply power and try again to adjust the output voltage to exactly 1.00 volt. Do you notice the better control now? YES/NO

What is the maximum voltage output you can obtain? _________volts.

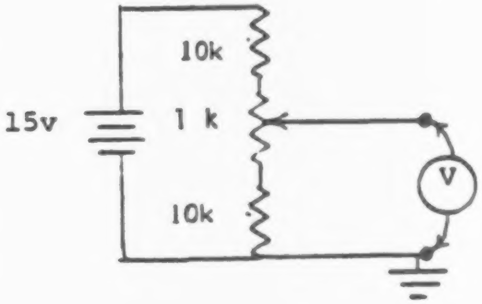
12. Reconnect the circuit as shown.



13. Adjust the voltage output for exactly 14 volts.
What is the minimum voltage output you can obtain? __________volts.

What do you think about this circuit? Fantastic / I've seen better / Dumb

14. Reconnect the circuit with two 10kohm resistors as shown.



15. Apply 15 volts and adjust the output to exactly 7.50 volts.
Notice the excellent control you have now, compared to the first circuit in which you adjusted the output to 7.5 volts.

16. Adjust the output to the maximum voltage: _________volts.

Adjust the output to the minimum voltage: _________volts.

SUMMARY

You have been experimenting with some circuits which involve much more than just setting output voltages. These voltage divider concepts are very important in many other circuits that you will study. Each time you come to a new circuit to study, look at it first to see if it is a form of a voltage divider circuit. If it is, then you are prepared to tackle it with all the concepts you know about voltage dividers. This can make some tough troubleshooting problems much easier.

PROJECT 4: Design a Voltage Divider (Do the computations outside of lab period time.)

Design and test a voltage divider circuit to provide the output voltages indicated. Use only 3 resistors: A 1kohm potentiometer and any two resistors from your Parts Kit. The voltage source is 15 volts. (Answer on last page.)

Output Voltages:
15.0 volts (not adjustable)
7.5 volts (not adjustable)
3.75 volts (not adjustable)
0 to 3.75 volts (adjustable)

Draw the schematic of your designed circuit and record the data indicated for it below.

I_T: ______mA

P_T: ______mW

P_{pot}: ______mW

Using the same resistors, design another voltage divider circuit providing these output voltages:

15 volts (not adjustable)
11 volts (not adjustable)
9 volts (adjustable 7.5 to 11 volts)
7.5 volts (not adjustable)

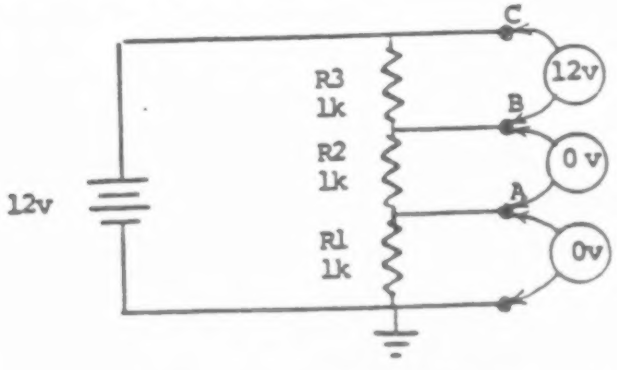
Draw the schematic of your circuit:

PROJECT 5: Theoretical Troubleshooting Quiz for Unloaded Voltage Dividers

INSTRUCTIONS

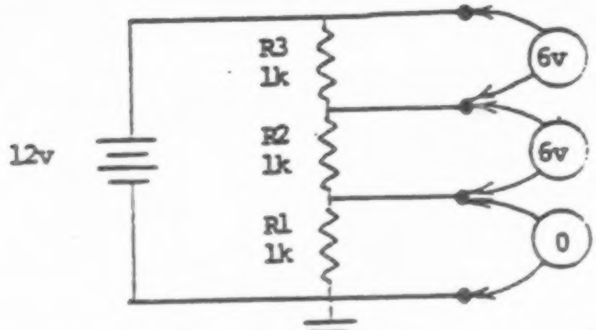
Study each schematic and the meter indications. Then determine what the trouble could be in the circuit. There is either an "open" or a "short" in each circuit. The "open" or "short", if in a potentiometer, will be in the section of the resistor between A - B or B - C. Select the most correct response from the multiple choices below each schematic. Check your responses with the answers on the last page.

1.



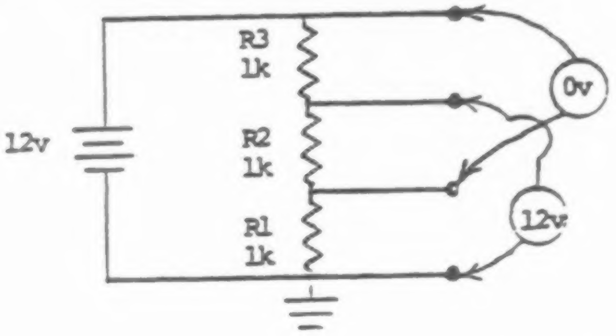
a. R1 open   b. R2 open   c. R3 open   d. R3 shorted

2.


R3
1k
R2
1k
R1
1k
12v
6v
6v
0

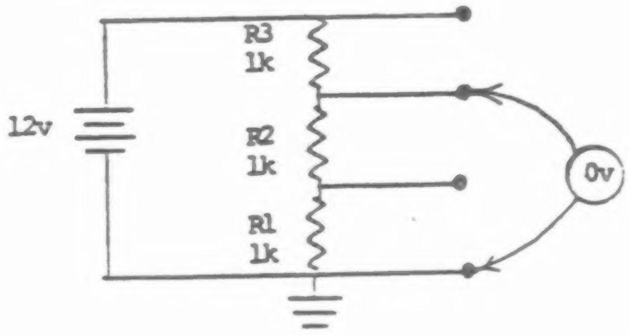
a. R1 open b. R1 shorted c. R2 open d. R3 open

3.


R3
1k
R2
1k
R1
1k
12v
0v
12v

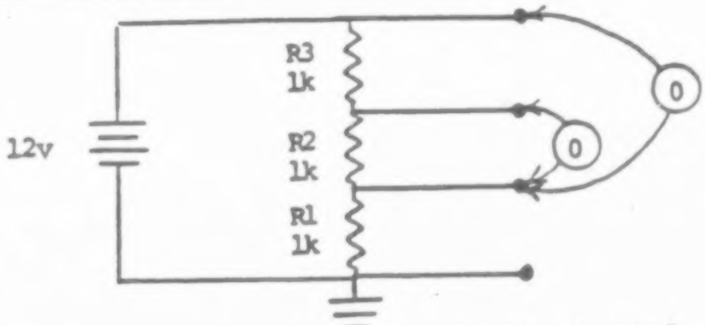
a. R1 open b. R1 shorted c. R2 shorted d. R2 open

4.


R3
1k
R2
1k
R1
1k
12v
0v

a. R1 open b. R2 open c. R3 open d. R2 shorted

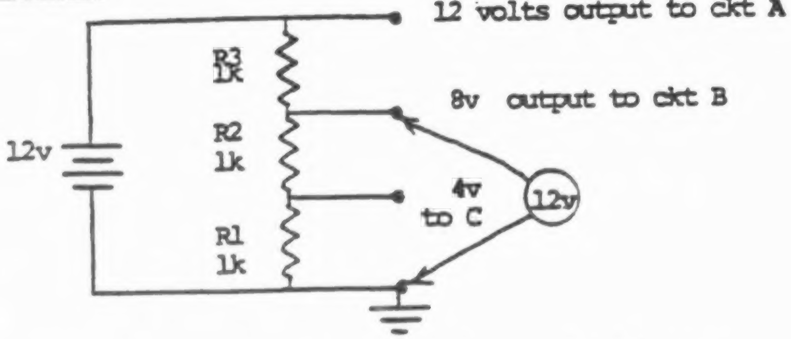
5.


R3
1k
R2
1k
R1
1k
12v
0
0

a. R1 open b. R1 shorted c. R3 open d. R3 shorted

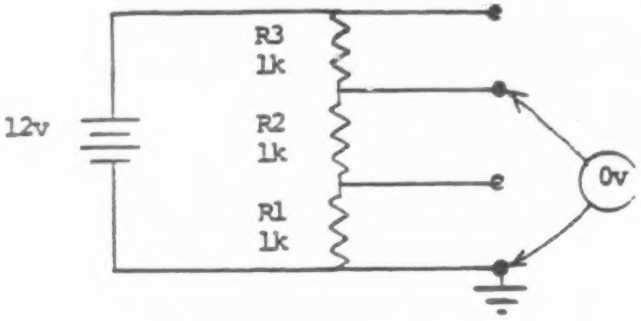
Note: The voltages to the circuits are what should normally appear at each point. The meter voltages are what appears with the trouble in the circuits.

6.


12 volts output to ckt A
R3
1k
8v output to ckt B
12v
R2
1k
4v
to C
12v
R1
1k

a. R1 shorted b. R2 shorted c. R3 shorted d. R3 open

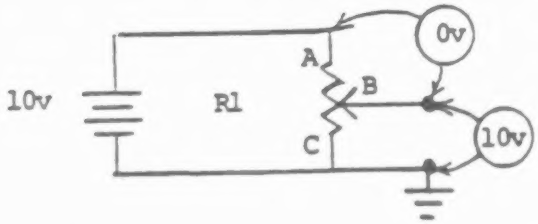
7.


R3
1k
12v
R2
1k
0v
R1
1k

a. R1 shorted b. R2 shorted c. R3 shorted d. R3 open

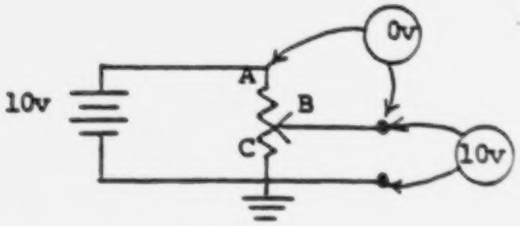
Note: All potentiometers are set one-half CW rotation of arm and are linear taper.

8.


0v
A
B
10v
R1
10v
C

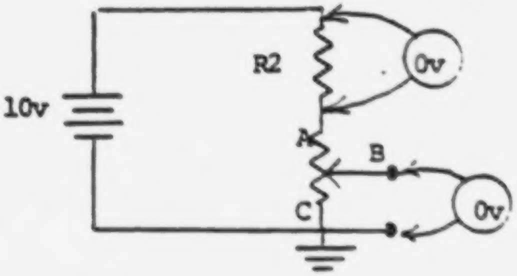
a. Open between A and B b. Open between B and C

9.


0v
A
10v
B
C
10v

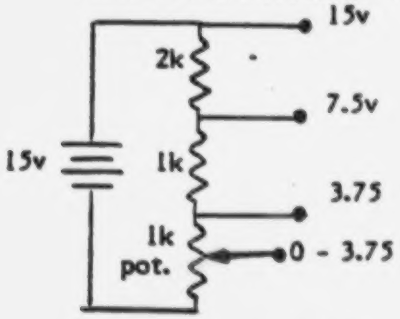
a. Shorted between A and B   b. Shorted between B and C

10.


R2
0v
10v
A
B
C
0v

a. R2 shorted   b. R1 shorted B-C   c. R1 open A-B

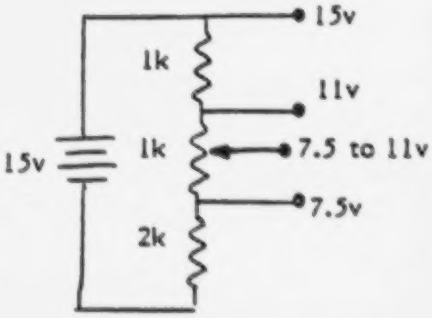
Answers to PROJECT 4.


15v
2k
7.5v
15v
1k
3.75
1k
pot.
0 - 3.75

I_T = 3.75 mA

P_T = 56.3 mW

$P_{pot.}$ = 14 mW


15v
1k
11v
15v
1k
7.5 to 11v
7.5v
2k

Answers to PROJECT 5.

1 c;   2 b;   3 a;   4 c;   5 a;   6 c;   7 d;   8 b;   9 a;   10 c

LOADED VOLTAGE DIVIDERS

Lab Sheet #11

OBJECTIVES

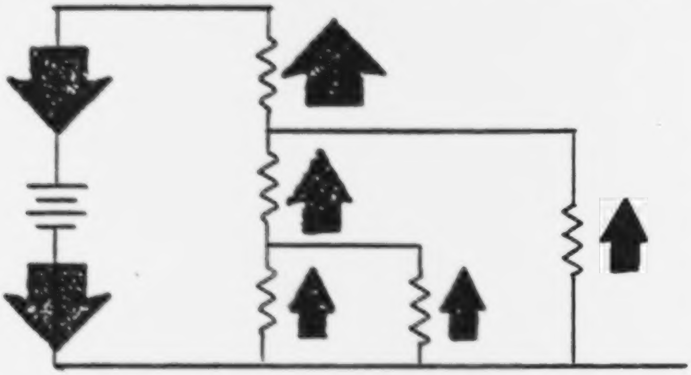
To learn how to test and measure loaded voltage dividers
To develop skill in troubleshooting voltage divider circuits

MATERIALS

DMM
Solderless Breadboard
Resistors: 3.3k, 4.7k, (2) 10k, 15k, (2) 33k

INTRODUCTION

So far, there has been only one path for current flow in the series circuits and voltage dividers that you studied. These were called unloaded voltage dividers. You will now connect a resistor in parallel with these voltage points on the voltage divider. These parallel resistors represent LOADS. They also pass current through the voltage divider. Below is shown an example of a loaded voltage divider. Study the different paths for current.



A loaded voltage divider is merely a series-parallel circuit. It is a common form of circuit used in electronic equipment. As a technician you will often work with LOADED VOLTAGE DIVIDER circuits.

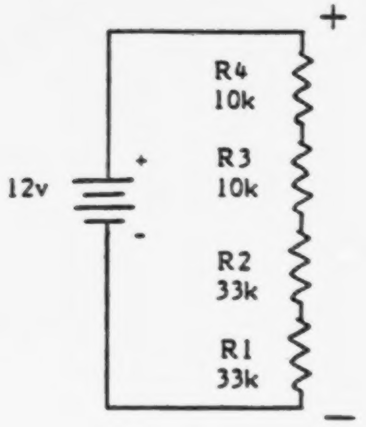
In PROJECT 1, first you will connect an unloaded voltage divider and make voltage measurements. Then, in PROJECT 2, you will place a LOAD on it and observe the effect of the load current on the various voltages.

PROJECT 1: Analyzing the Unloaded Voltage Divider Circuit

1. Select and measure the actual resistance of these resistors:

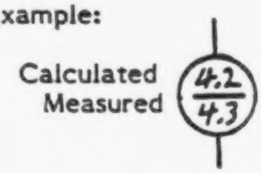
R1(33k)________ R2(33k)________ R3(10k)_______ R4(10k)________

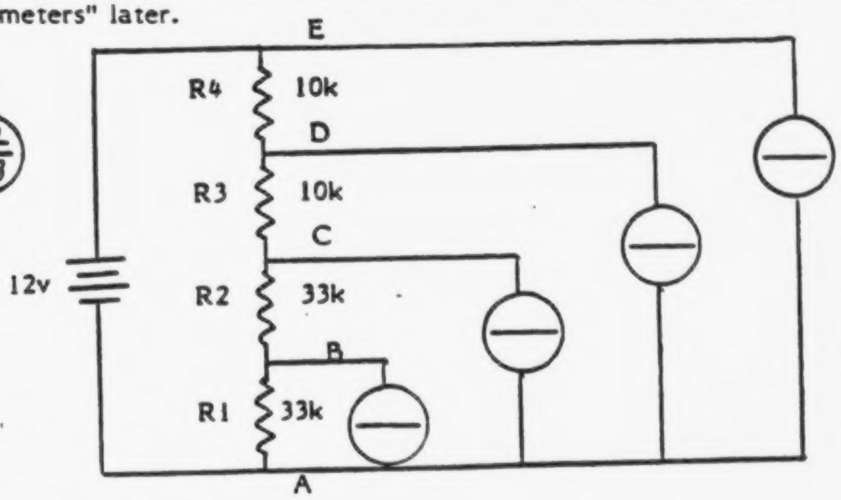
2. Connect the circuit shown below. Do not turn the power "on" yet. Insure that the polarity of the power supply is connected as shown. The negative end will be used as the reference point for all measurements.


+
R4
10k
R3
10k
12v
+
-
R2
33k
R1
33k
—

3. Calculate the voltage from point A to each of the other points. Write the voltage calculated in the upper half of each circle on the schematic below. The circles represent voltmeters. The measured values will be written in the lower half of the "meters" later.

Example:


Calculated
Measured
4.2
4.3


E
R4
10k
D
R3
10k
C
12v
R2
33k
B
R1
33k
A

4. Now apply power and measure the voltages. Record it in the "meters" in STEP 3.

5. Compare the calculated and measured values. Are they close? YES/NO

6. Calculate the power dissipated in the resistors:

P_{R1}:______mW P_{R3}:______mW

P_{R2}:______mW P_{R4}:______mW

SUMMARY

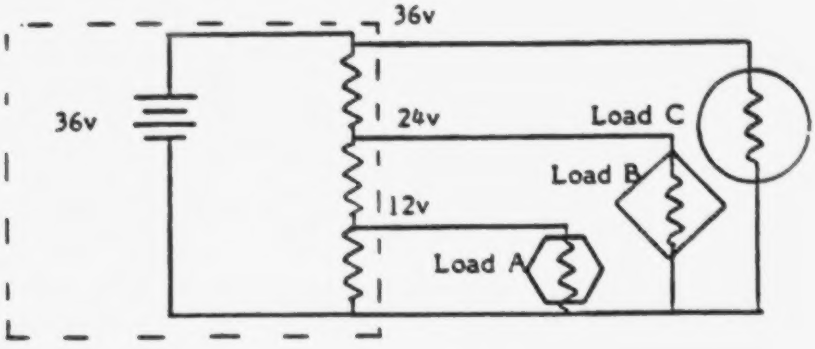
You should have observed that the voltage divider voltages were close to what you calculated. Also, you should recognize that this is a simple series circuit with only one path for current flow. Next you will put a load on this circuit and see how a load affects the voltages. NOTE: When we speak of a load, we are referring to the current. However, to pass the current we need a resistor. So sometimes it sounds like the load is the resistor.

PROJECT 2: Analyzing the Loaded Voltage Divider Circuit

INTRODUCTION

This voltage divider is the type of a circuit which might be in a power supply to distribute various voltages to different loads. The loads could be different equipment or different circuits in a piece of equipment. Notice that the voltage divider is inside the power supply, which is represented by the dashed lines.

Example:
(Do not connect
this circuit.)



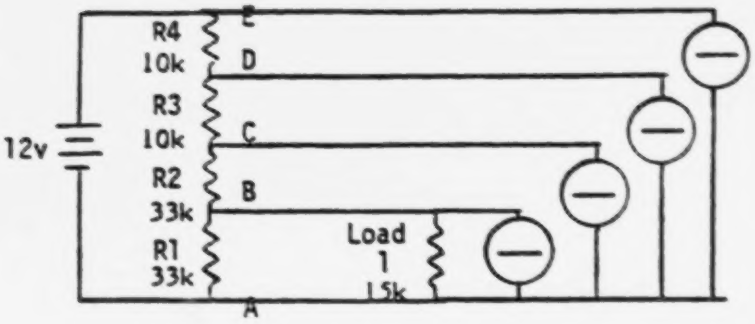
A very important concept to learn in this Project about a loaded voltage divider is this: The current through each load affects the voltage outputs. Study this well. It has many applications and causes many problems.

INSTRUCTIONS

1. Measure the resistance of a 15kohm resistor and record. Call it Load 1.

Load 1:________kohms

2. Connect Load 1 resistor across R1 as shown. This 15k resistor will represent a load such as a complete and separate circuit.



3. Calculate the new voltages for points B, C, D, and E. (See note below). Record in the "meters" above.

NOTE: You now have a different circuit than before. None of the voltages will be the same except the applied voltage. To calculate the voltages, take the time to understand what is occurring and work this out as a series parallel circuit.

HINTS: R1 and Load 1 form a parallel circuit now. This causes more current to flow through the R2, R3, R4 portion of the voltage divider. Therefore, more voltage will be dropped across each resistor. One way to calculate the new voltages is this:

a. Calculate Req (equivalent resistance) of R1 and Load 1.

b. Redraw the circuit with Req as one resistor in series with R2, R3, R4.

c. Treat the redrawn circuit as an unloaded voltage divider and find R_T, I_T and voltage at points B, C, D and E.

4. Redraw the original circuit with R1 and Load 1 in parallel, after finding the voltages at points B, C, D and E. Calculate the current through R1 and Load 1 now that you have the voltage across each.

5. Calculate the power dissipated in each resistor. (Use calculated values.)

Load 1:_____mW. R1:_____mW. R2:_____mW. R3:_____mW. R4:_____mW.

Will any resistor exceed its wattage rating when power is applied? YES/NO

6. Apply power to the circuit and measure the voltages. Record on the STEP 2 schematic in the lower portion of the "meters".

7. Compare your calculated and measured values. Are they close? YES/NO

8. It is important to observe that adding Load 1 to the voltage divider caused the voltage to change. Analyze what has changed by adding Load 1:

a. How many volts did point B drop when Load 1 was added?

Unloaded point B volts:________
Loaded point B volts:________
Difference:________volts

b. What percentage change in voltage occurred at point B with Load 1 added?

$$\% = \frac{\text{Difference}}{\text{Unloaded B volts}} \times 100 = \underline{\hspace{3em}}\,\%$$

c. How many volts did point C drop when Load 1 was added?

Unloaded point C volts:________
Loaded point C volts:________
Difference:________volts

d. What percentage change in voltage occurred at point C with Load 1 added?

$$\% = \frac{\text{Difference}}{\text{Unloaded C volts}} \times 100 = \underline{\hspace{3em}}\,\%$$

e. How many volts did point D drop when Load 1 was added?

Unloaded point D volts:________
Loaded point D volts:________
Difference:________volts

f. What percentage change in voltage occurred at point D with Load 1 added?

$$\% = \frac{\text{Difference}}{\text{Unloaded D volts}} \times 100 = \underline{\hspace{3em}}\,\%$$

g. How many volts did point E drop when Load 1 was added?

Unloaded point E volts:________
Loaded point E volts:________
Difference:________volts

h. What percentage change in voltage occurred at point E with Load 1 added?

$$\% = \frac{\text{Difference}}{\text{Unloaded E volts}} \times 100 = \_\_\_\_\_\_\%$$

i. How much power was each resistor dissipating? (Use measured values.)

Load 1:_____mW. R1:_____mW. R2:_____mW. R3:_____mW. R4:_____mW.

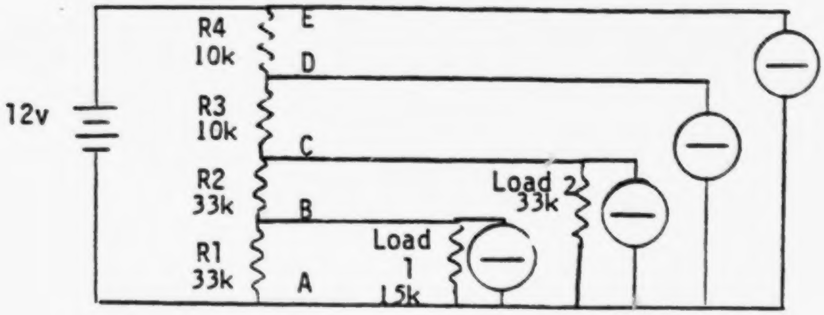
j. Compare these measured values with the calculated values in STEP 5 above.

k. Which resistors are dissipating more power now that Load 1 is in the circuit?

(Circle) R1 R2 R3 R4

9. Now measure and add Load 2 (33Kohms) to the circuit as shown below.

Load 2 (33k):_________kohms.



Notice that there are now three paths for current flow: up through R1, Load 1, and Load 2. (NOTE: The voltmeters are not passing any significant current.) These individual currents combine and are all flowing through R3 and R4. You will notice even more significant changes in the voltage divider output voltages.

10. Calculate the voltages at points B, C, D, and E. You now have a new circuit and different voltages, so treat this as a new problem. You can use the following procedure to calculate the new values:

a. Using the redrawn circuit with "Req" from STEP 3 above, calculate the series resistance of Req and R2. Call it Req_2.

b. Calculate parallel resistance of Req_2 and Load 2. Call it Req_3.

c. Redraw the circuit as an unloaded series voltage divider consisting of Req_3, R3, and R4.

d. Calculate R_T, I_T, and voltage at points C, D and E.

e. Redraw and calculate the current through Req_2 and Load 2.

f. Redraw and calculate the voltage at point B.

g. Redraw and calculate the current through Req_1 and Load 1.

11. Calculate the power dissipated in each resistor.

Load 1:____mW. Load 2:____mW. R1:____mW. R2:____mW. R3:____mW. R4:____mW.

Will any resistor exceed its wattage rating when power is applied? YES/NO

12. Apply power to the circuit and measure the voltages. Record on the above schematic in the lower portion of the "meters".

13. Compare your calculated and measured values. Are they close? YES/NO

14. It is important to observe that adding Load 2 to the voltage divider caused the voltage to change even further. Analyze in detail what has changed by adding Load 2. (NOTE: "Unloaded" voltage is without any loads.)

a. How many volts did point B drop when Load 2 was added to the voltage divider?

Unloaded point B volts:________
Loaded point B volts:________
Difference:________volts

b. What percentage change in voltage occurred at point B with Load 2 added?

$$\% = \frac{\text{Difference}}{\text{Unloaded B volts}} \times 100 = \_\_\_\_\_\_\%$$

c. How many volts did point C drop when Load 2 was added?

Unloaded point C volts:________
Loaded point C volts:________
Difference:________volts

d. What percentage change in voltage occurred at point C with Load 2 added?

$$\% = \frac{\text{Difference}}{\text{Unloaded C volts}} \times 100 = \underline{\qquad\quad}\%$$

e. How many volts did point D drop when Load 2 was added to the voltage divider?

Unloaded point D volts:________
Loaded point D volts:________
Difference:________volts

f. What percentage change in voltage occurred at point D with Load 2 added?

$$\% = \frac{\text{Difference}}{\text{Unloaded D volts}} \times 100 = \underline{\qquad\quad}\%$$

g. How many volts did point E drop when Load 2 was added to the voltage divider?

Unloaded point E volts:________
Loaded point E volts:________
Difference:________volts

h. What percentage change in voltage occurred at point E with Load 2 added?

$$\% = \frac{\text{Difference}}{\text{Unloaded E volts}} \times 100 = \underline{\qquad\quad}\%$$

i. How much power was each resistor dissipating?

Load 1:____mW.

Load 2:____mW.

R1:____mW.

R2:____mW.

R3:____mW.

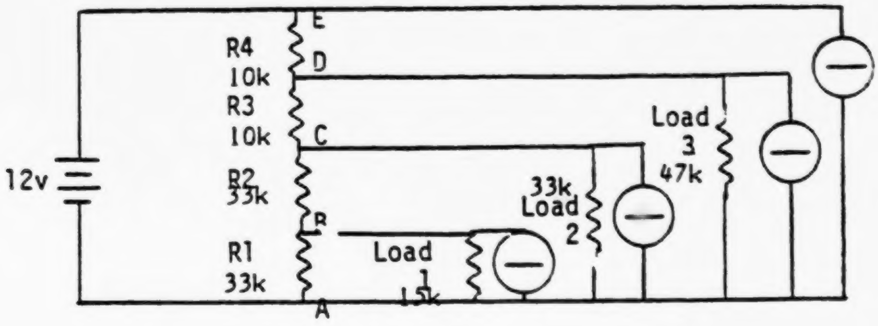
R4:____mW.

j. Which resistors dissipate more power now that Load 2 is in the circuit?

(Circle) R1 R2 R3 R4

15. Now, without any further instructions, see if you can calculate and measure the voltages on the circuit below. Notice that this is the same circuit on which you have been working, except one more load has been added (Load 3, 47kohms).

Do the same calculations and use the same procedures used in PROJECT 2.



R_T:______

I_T:______

Record the voltages on this schematic.

Are your measured and calculated values close? YES/NO

Calculate the power dissipated in each resistor:

Load 1:_____mW. Load 2:_____mW. Load 3:_____mW.

R1:_____mW. R2:_____mW. R3:_____mW. R4:_____mW.

Is the wattage rating of any resistor exceeded? YES/NO

SUMMARY

The concepts you learned so laboriously in this project are very important. Most of the circuits you will be working on are forms of loaded voltage dividers. Once you understand the current flow and voltage drop rules for these types of circuits, you can be an extremely effective troubleshooter. The following project will let you practice your new skills.

Meters and Load Matching

Lab Sheet # 12

OBJECTIVES

To learn how to prevent incorrect voltage readings in certain circuits
To learn how to measure internal resistance in a source of power
To learn how to match a load to a power source for maximum power output
To learn how to extend the range of an ammeter
To learn how to make a voltmeter out of an ammeter

MATERIALS

Precision Resistor Board
VTVM OR VOM

PROJECT 1: Inaccurate Voltage Measurements in High Resistance Circuits

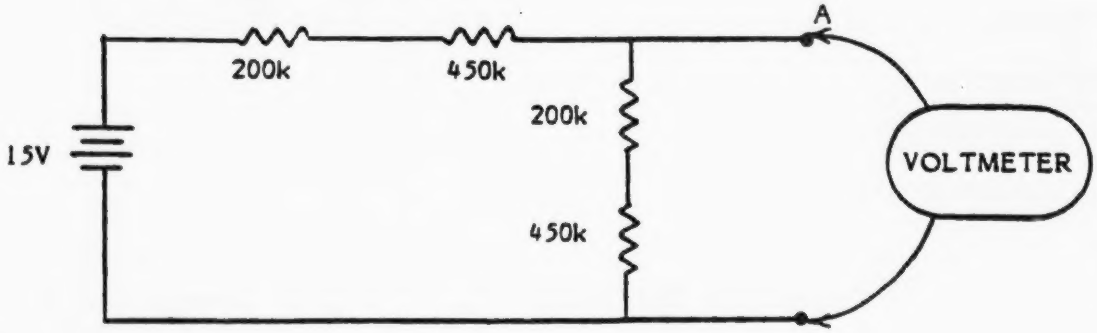
INTRODUCTION

This Project is intended to make you aware of how INACCURATE voltage measurements can occur due to the loading effect of the voltmeter. As a technician you must be aware of this phenomena to prevent costly mistakes.

INSTRUCTIONS

1. Calculate what the voltage will be in the below circuit at point A with no load attached.

Point A voltage:________volts (Calculated)



2. Using the Precision Resistor Board, connect the circuit in STEP 1.

3. Apply power and measure the voltage at point A using the VTVM.

Point A voltage:________volts (VTVM)

4. Remove the VTVM and use the DMM to measure the voltage at point A.

Point A voltage:________volts (DMM)

Do you get a different voltage than you did in both STEPS 1 and 3? YES/NO

5. With the DMM still measuring point A, also measure point A voltage with the VTVM. (NOTE: The voltmeters will be in parallel measuring point A voltage.)

Do you get still a different voltage from all the other readings? YES/NO

6. What percentage did the measured voltage differ from the calculated voltage?

$$\% = \frac{\text{Calculated - measured}}{\text{Calculated voltage}} \times 100$$

VTVM:________%

DMM:________%

SUMMARY

Normally, the very high resistance of a good quality voltmeter does not affect the circuit measured. However, when the circuit series resistance is very high, the voltmeter may affect the circuit and give you an inaccurate reading. In PROJECT 1, the voltmeters were acting like a load on a voltage divider and the voltage was affected.

PROJECT 2: Determining the Internal Resistance of a Power Source

INTRODUCTION

You should recognize that all electronic components have resistance, and that the resistance can cause undesirable effects. This is especially true in power sources such as batteries, DC and AC power supplies, and signal or function generators. You should always remember that any power or signal source has internal resistance present, causing it to have some effect on the operation. If you understand this important principle, you can be a more effective technician and make fewer mistakes. As you do this Project, observe and keep these things in mind:

All equipment which produces power or signals has internal resistance.

The internal resistance becomes part of the circuit to which it is externally connected.

The internal resistance will drop voltage and dissipate power just as any other series resistors in the external circuit will do.

As current demands increase in the external circuit, the internal resistance will drop more voltage and dissipate more power (that is, it will get hot and waste more power).

In order to get maximum power to the load, the load resistance must be the same value as the source internal resistance.

In this Project the internal resistance of a power source will be exaggerated. You will be using an alternating current (AC) power transformer which has an additional resistor added to simulate a higher than normal internal resistance. We have attempted to make this rather good quality transformer appear as a very poor quality one with very small wire. The resistor representing internal resistance is mounted on a terminal board near the transformer.

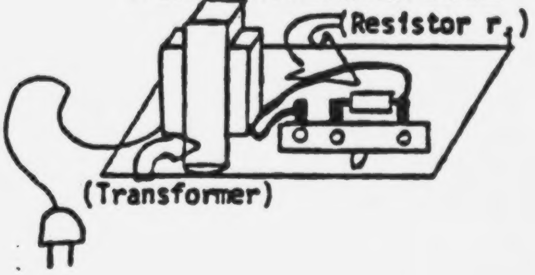
You will learn another important skill as you do this Project: how to INDIRECTLY measure a resistance that you cannot measure directly with an ohmmeter.

MATERIALS

Special Transformer Board
Decade Box
DMM

(NOTE: Be sure you get the transformer board with the terminal board and resistor mounted similarly to the drawing below.)

SPECIAL TRANSFORMER BOARD



INSTRUCTIONS

1. Obtain the Special Transformer Board with the unmarked resistor. Also get a Resistor Decade Box. The Decade Box will serve as a load on the transformer. The Decade Box is adjustable in steps to precise resistance values.

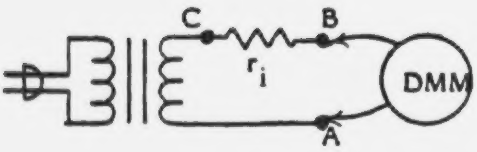
NOTE: Do not try to measure the 110 volt AC input from the bench AC power outlet where you plug in the transformer. Only measure AC voltage at points "A" and "B" on the transformer board. Be sure to set the voltmeter for "AC VOLTS".

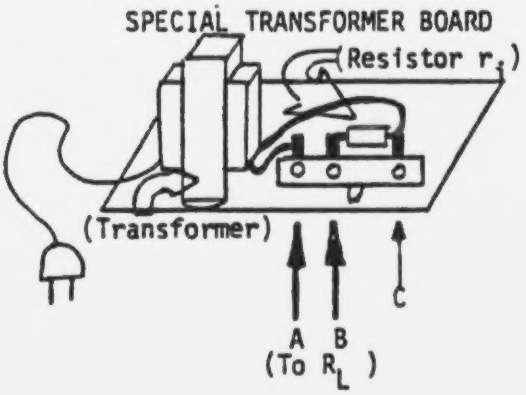
Do not use the ohmmeter unless directed to do so.

Do not switch the Decade Box to 0 ohms.

2. Measure the "No Load" AC voltage out of the transformer using this procedure:

- a. Set the DMM for "AC Volts".
- b. Plug the transformer into the bench 110 AC outlet.
  Do not connect a load to the transformer until directed to do so.
- c. Measure the AC volts between points "A" and "B" using the DMM. (See the drawing below.) This is the "No Load voltage"(Vnl). Record below.

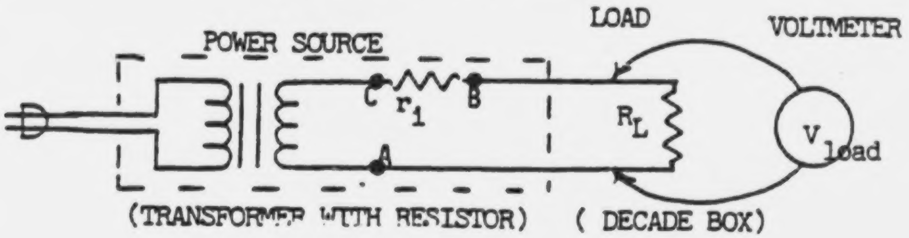



SPECIAL TRANSFORMER BOARD
(Resistor r_i)
(Transformer)
A
B
C
A B
(To R_L)

No Load voltage(Vnl):________acv

3. Take a moment to study the Decade Box. Note that one switch changes the resistance at the terminals by 1 ohm each step. The next switch changes 10 ohms per step. The next jumps 100 ohms per step, etc. All resistances in the box are in series, so the total resistance is determined by adding all switch indicated values. CAUTION: Do not turn all Decade Box knobs to 0 -- the Decade Box fuse may blow!

4. Connect the Decade Box as a load (R_L) as shown below. Connect the voltmeter in parallel with the Decade Box as shown. Make sure you connect to points "A" and "B" on the transformer board. Do not connect anything to point "C" or to the 110 AC volt side of the transformer.


LOAD
VOLTMETER
POWER SOURCE
C
r_1
B
R_L
V_{load}
A
(TRANSFORMER WITH RESISTOR)
(DECADE BOX)

5. With the transformer plugged into the 110 AC volts, adjust the Decade Box resistance while observing the voltmeter. Adjust the Decade Box resistance for a value so that the voltmeter reads exactly one-half of the "no-load" voltage (Vnl) from STEP 2c. Call this the "Loaded voltage"(Vload) and record below.

Vload:________acv

6. Read the value resistance to which the Decade Box was set to achieve Vload.

Decade Box resistance:__________ohms.

7. Study what you did. You should recognize that you adjusted the Decade Box resistance to the value of the internal resistance of the transformer and the unknown resistor. Since you just made a voltage divider circuit with two equal resistances, the "Loaded voltage" will be one half of the "No Load voltage".

NOTE: This simple "voltage divider" technique of indirectly measuring resistance has many applications in electronics testing. Before going to the next Project, be sure that you understand this important technique.

8. Verify that the additional formula below also works to determine internal resistance(r_i). However, you must first use the previous voltage measurements and calculate current(I_L) using Ohm's Law.

$$\text{Internal resistance } (r_i) = \frac{\text{Vnl} - \text{Vload}}{I_L} = \_\_\_\_\_\_\_\_\_\_\text{ohms.}$$

9. Try the formula above using a different value of resistance for the Load. It should work for any value, so set the Decade Box to any arbitrary number such as your weight or telephone number. Find the internal resistance (r_i) using STEP 8 formula.

r_i = __________ohms.

Is the r_i calculated here in the same way as in STEP 6? YES/NO

NOTE: In electronics notation, capital letters are used for DC values and small letters are used for AC values. Since this power source is AC, the internal resistance is designated "r_i" with small letters.

PROJECT 3: Matching Load Resistance to Source Resistance for Maximum Power Transfer to the Load

INTRODUCTION

In this Project you will observe that maximum power is transferred to the load ONLY when the load resistance is EQUAL to the source internal resistance. This very important principle is evident in many areas of electronics. Two examples where this is used are: (1) matching loudspeakers to the amplifier and (2) matching the TV antenna lead-in to the antenna and TV set. If the AC resistance (called impedance) is not equal, there will be a loss of power and performance will be less efficient.

Use the same circuit and equipment for this Project that you used in PROJECT 2.

INSTRUCTIONS

1. To prepare your upcoming graph reference points, you must calculate the required Decade Box resistance settings. The settings are to achieve certain ratios between R_L (that is, the Decade Box) and r_i (that is, the source of power). The ratio values are listed in TABLE 1 below, under "Ratio".

PROCEDURE

a. Record in TABLE 1 (on every line) under "r_i" the value of r_i found in PROJECT 2, STEP 6.

b. Calculate each needed value of R_L (that is, the Decade Box setting) to achieve the listed ratios. Use this formula:

$$R_L = r_i \text{ X ratio}$$

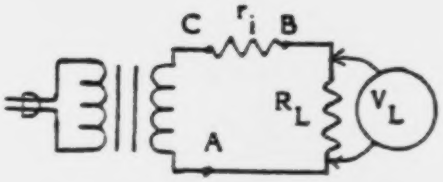
Example for first entry in TABLE 1: (we will assume r_i = 800 ohms)

$$R_L = 800 \text{ X } .1 = 80$$

(We would enter 80 under R_L in TABLE 1). We would then calculate R_L for a ratio of .2, .4, .6, etc.

2. After the values of R_L have been calculated for each ratio and recorded in TABLE 1, set the Decade Box to each value of R_L and measure the voltage across R_L. Record each voltage in TABLE 1 under "V_L".

3. Calculate the power for each different load value. Record in TABLE 1 under "Power in Load".



$$P = \frac{(V_L)^2}{R_L}$$

TABLE 1

Ratio	r_i		R_L	V_L	Power in Load
.1		r_i X .1 =			
.2		r_i X .2 =			
.4		r_i X .4 =			
.6		r_i X .6 =			
.8		r_i X .8 =			

(TABLE 1 is continued on PAGE 7)

TABLE 1 (continued)

Ratio	r_i		R_L	V_L	Power in Load
1	______	$r_i \times 1 =$	________	________	________
2	______	$r_i \times 2 =$	________	________	________
4	______	$r_i \times 4 =$	________	________	________
6	______	$r_i \times 6 =$	________	________	________
8	______	$r_i \times 8 =$	________	________	________
10.	______	$r_i \times 10 =$	________	________	________

4. On the attached graph paper, plot the "Power in Load" values (vertical axis) versus "Ratio" (horizontal axis). Connect all points to show that maximum power in the load occurs when the ratio is 1 (that is, when $r_i = R_L$).

SUMMARY

Remember this:

When the load resistance is equal to the internal resistance of the power source, maximum power will be transferred to the load.

PROJECT 4: Extending the Range of an Ammeter to Read Twice(2X) the Amount of Current

INTRODUCTION

Be sure that you have read the reading assignment before doing this Project.

In this Project you will be converting a milliammeter movement to read twice the original value for which it was made to measure. We will assume that the meter you will be given to convert has a 1 mA meter movement. That is, the full scale reading goes to 1 mA. You will make a simple circuit with this 1 mA meter and a resistor (called a "SHUNT") to make a "new ammeter circuit" which will measure 2 mA. Then you will make another "new ammeter circuit" to measure 5 mA. The milliammeter you will be given for this may be different than 1 mA full scale, but the principle will be the same. Using these principles you should be able to convert any ammeter to read a higher current than it was originally designed to measure.

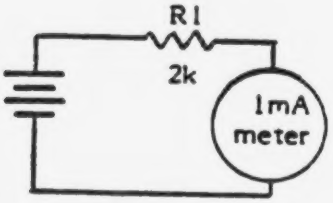
Be sure that you have read the reading assignment on meter shunts before attempting this Project.

MATERIALS

Ammeter movement (1 mA full scale deflection)
Decade Box
Resistor: 2k

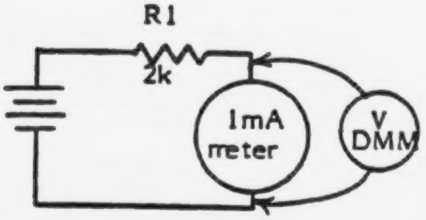
INSTRUCTIONS

1. Find the voltage at which the ammeter movement is reading full scale deflection by using this procedure:



a. Connect the circuit shown. R1 value is not critical. It is in the circuit only as a load since the ammeter resistance is very low. Further, it lets us find the circuit current by measuring the voltage drop. Measure the resistance of R1 (2k):_________.

b. Turn the power supply ON. Increase the voltage slowly until the ammeter reads full scale.
It should rest over the last mark on the right end of the scale. Leave the voltage set at the value where this occurs.



c. Using the DMM, measure across the meter and accurately measure the voltage which caused the full scale deflection. Record. Emeter:________volts for full scale.

$$I_T = \frac{E_{R1}}{R1}$$

d. Measure the voltage drop across R1 and calculate circuit current: ________mA. Is it the same as the ammeter is reading? If not, use the value calculated for the remainder of the calculations in this Project.

2. Using the value you measured for Emeter (1c), calculate the required shunt resistor needed to extend the range of the ammeter to read 2 mA full scale. This means that with the proposed shunt in the circuit, R1 will have 2 mA flowing and the ammeter will deflect full scale as it was. One mA will flow through the meter (as before), and 1 mA will flow through the shunt resistor.

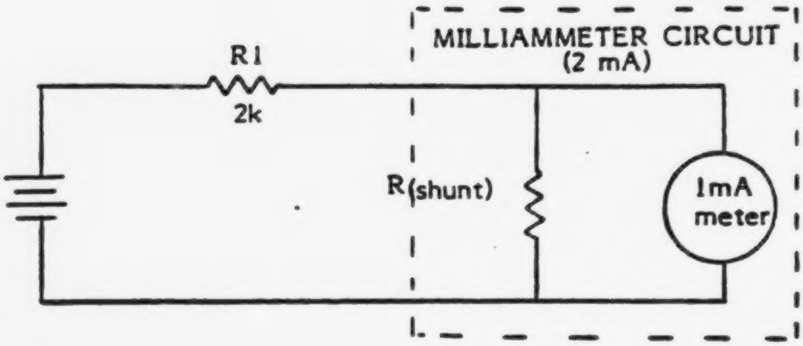
$$R(\text{shunt}) = \frac{E(\text{shunt})}{I(\text{shunt})}$$

where E(shunt) = Emeter, since they are in parallel

where I(shunt) = I_T - Imeter

R(shunt)=________ohms

3. Connect the ammeter circuit below using the Decade Box as R(shunt). Do not turn power ON.



4. Calculate what voltage should be across R1 for full scale deflection of the ammeter with the shunt in the circuit. E_{R1}=________volts.

5. Turn the power on and adjust the power supply voltage until the voltage across R1 (E_{R1}) reads the value calculated in STEP 4. Monitor the ammeter to insure you don't "peg" the needle.

6. The ammeter scale numbers should be multiplied by 2 to determine the current in the circuit. Lower the power supply voltage to approximately half, and check to see if this is true by comparing the R1 calculated current with the ammeter reading.
Try several different current values to check the linearity of the meter.

Imeter________ $\times 2 = I_{R1} = \frac{E_{R1}}{R1} =$ ________mA.

Imeter________ $\times 2 = I_{R1} = \frac{E_{R1}}{R1} =$ ________mA.

7. Now check your meter accuracy by placing the DMM milliammeter in series with the power supply and R1. Vary the power supply voltage and compare the two ammeter readings.

Is your new ammeter circuit accurate? YES/NO

8. Calculate the following for the STEP 3 circuit (use your recorded data):

a. What is the resistance of the ammeter without shunt? ________ohms.

b. What is the resistance of the new ammeter circuit with shunt? _____ohms.

c. How much power is the shunt dissipating? __________watts.

d. How much power is the ammeter and shunt dissipating? ________watts.

e. How much power is R1 dissipating? ___________watts.

9. Do you understand what you have done in this Project to make the ammeter movement read quite accurately up to 2 mA? YES/NO

If you answered "yes", continue with PROJECT 5. If not, repeat PROJECT 4.

PROJECT 5: Extending the Range of an Ammeter 5 Times(5X)

INTRODUCTION

Using the resistance shunt, you can extend the range of an ammeter to any higher range for which you can make a shunt resistor. Wattage rating of the resistors in the circuit becomes important as the current increases.

In this Project you will extend the range of the same ammeter to read five times full scale (that is, 5mA full scale deflection). Minimum instructions will be given so you can apply what you have learned. Use the same circuit and equipment that you used in PROJECT 4. Some of your previous data will be useful, too.

INSTRUCTIONS

1. Calculate the value of the shunt required to make a 5 mA ammeter (using the 1 mA range on the ammeter movement). Record indicated data below.

Meter full scale value with proper shunt will be:_________mA

Resistance of shunt:___________ohms.

Power dissipated in shunt:________watts.

Power dissipated in R1:________watts.

2. Draw your proposed ammeter circuit below.

3. Connect the proper shunt to the ammeter and check it as done in PROJECT 4 for the 2X circuit. (NOTE: You may not be able to set the Decade Box to the exact value resistance needed for the shunt. To make your ammeter read accurately, see if you can find a fixed resistor which can be connected in parallel with the Decade Box to produce the desired exact value shunt.)

Fixed resistor value:________ohms; ________watts

4. Does your ammeter circuit operate accurately at all values of current up to 5 mA?

YES/NO

SUMMARY

Now you know how to make an extended range ammeter using the shunt resistor principle. You should now be able to use a "junk box" meter to make a reasonably accurate ammeter with one or more extended ranges.

PROJECT 6: Construction of a 10 Volt Voltmeter from an Ammeter

INTRODUCTION

All analog or D'Arsonval type of voltmeters in common use are milliammeter (or microammeter) movements, with a SERIES resistor. The scale on the milliammeter movement is marked and calibrated for volts, however. The series resistor makes the voltmeter a high resistance device, whereas the shunt resistor makes the ammeter (like PROJECT 5) a low resistance device.

The voltage dropped across any ammeter at full scale deflection is very low. Therefore, the series resistor must drop the remainder of the voltage applied. We will call the series resistor "Rseries". Knowing the voltage dropped across Rseries, and the full scale current through Rseries, will allow you to calculate its required resistance using Ohm's Law.

In this Project you will make a voltmeter using an ammeter and a suitable value series resistor. You will use the same 1 mA ammeter movement and the Decade Box to make your 10 volts voltmeter.

INSTRUCTIONS

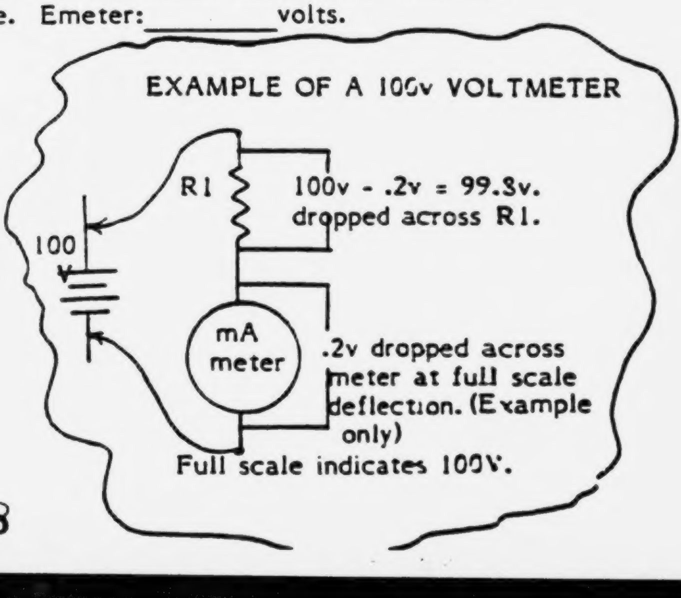
1. Record the voltage dropped across your 1 mA ammeter movement. This was determined in STEP 1c, PROJECT 4 above. Emeter:_________volts.

2. Calculate how many volts must be dropped by Rseries:

$$10V - E_{meter} = E_{Rseries} = \_\_\_\_\_\_ \text{volts.}$$

3. Calculate the value of Rseries:

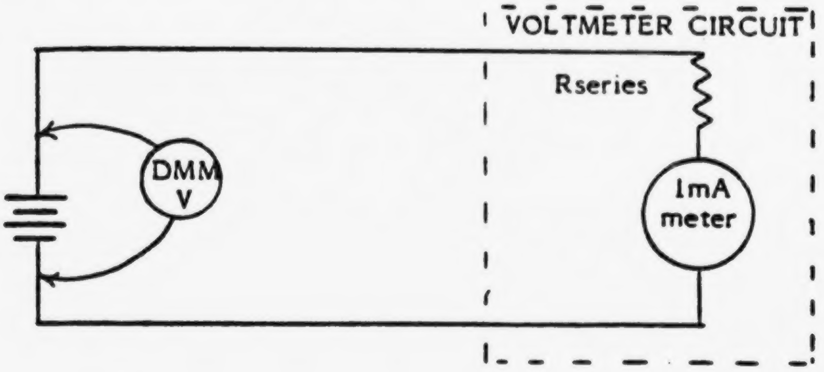
$$R_{series} = \frac{E_{Rseries}}{I_T} = \_\_\_\_\_\_ \text{ohms.}$$


EXAMPLE OF A 100v VOLTMETER

R1
100v - .2v = 99.8v.
dropped across R1.
100
V
mA
meter
.2v dropped across meter at full scale deflection. (Example only)
Full scale indicates 100V.

4. Calculate the power dissipated in Rseries at full scale deflection: $P_{Rseries}$:_____watts.

5. Connect your voltmeter circuit and the test circuit shown. Raise the power supply voltage slowly to each voltage shown below and check the operation of your voltmeter circuit.



DMM voltage:	Your voltmeter circuit should indicate:	Does it?
2.5v	1/4 scale deflection = 2.5v	YES/NO
5.0v	1/2 scale deflection = 5.0v	YES/NO
7.5v	3/4 scale deflection = 7.5v	YES/NO
10.0v	Full scale deflection = 10.0v	YES/NO

PROJECT 7: Designing, Constructing, and Testing a 25 Volt Voltmeter

INSTRUCTIONS

1. Now design, construct, and test a 25 volt voltmeter while using the principles learned in PROJECT 6. Use the same 1 mA ammeter movement and Decade Box. Draw the circuit with values below.

Rseries:________ohms

$P_{Rseries}$:_________watts

2. Set up a test circuit as done in PROJECT 6, STEP 5, and show the instructor how your meter reads the maximum voltage from the power supply.

3. How did you do? (circle one) Fantastic So-so Blew-it

SUMMARY

You should have learned how to do these basic design, construction, and testing skills:

Extend the range of an ammeter to any practical range.

Make a voltmeter for any practical range desired.

Set up a testing and calibration circuit for your new meters.

PROJECT 8: Evaluation Quiz

INSTRUCTIONS

Select the correct response to complete the statements.

1. A voltmeter is really a sensitive ammeter calibrated in volts with a resistor in _______ with the ammeter.

   a. series b. parallel c. tandom

2. Since an ammeter has very low internal resistance, a resistor must be in the circuit to ________________________________.

   a. limit the current. b. balance the circuit for 0 volts.

3. A high quality voltmeter should have________________________.

   a. low resistance. b. high resistance. c. lots of buttons.

4. Internal resistance in a power supply or battery may cause the _______ to drop when heavy current is passed to the load.

   a. price b. weight c. voltage d. resistance

5. Maximum power is only possible in a load when the load resistance _______.

   a. is low. b. is high. c. equals the power source resistance.

6. When the load resistance is lower than the power source resistance, __________will be high at the load but _______will be low.

   a. voltage, current
   b. current, voltage
   c. power, price
   d. price, power

7. The antenna is the load and the transmitter is the power source. When the transmitter internal resistance is 300 ohms, the antenna should have______ ohms resistance for maximum power transfer to the antenna.

a. 50 b. 150 c. 300 d. maximum

8. The internal resistance in a power source causes the __________ to decrease as the load______________.

a. voltage, becomes lighter.
b. current, resistance decreases.
c. current, resistance increases.
d. voltage, current increases.

9. Select the proper value shunt resistor to make a 0-100 mA meter out of a 0-1.0mA meter which has 15 ohms internal resistance.

a. .152 ohms
b. 1.52 ohms
c. 15.2 ohms
d. 152 ohms
e. 1500 ohms

10. Select the proper value series resistor to make a 0-100 volt meter out of a 0-1.0mA meter which has 15 ohms internal resistance.

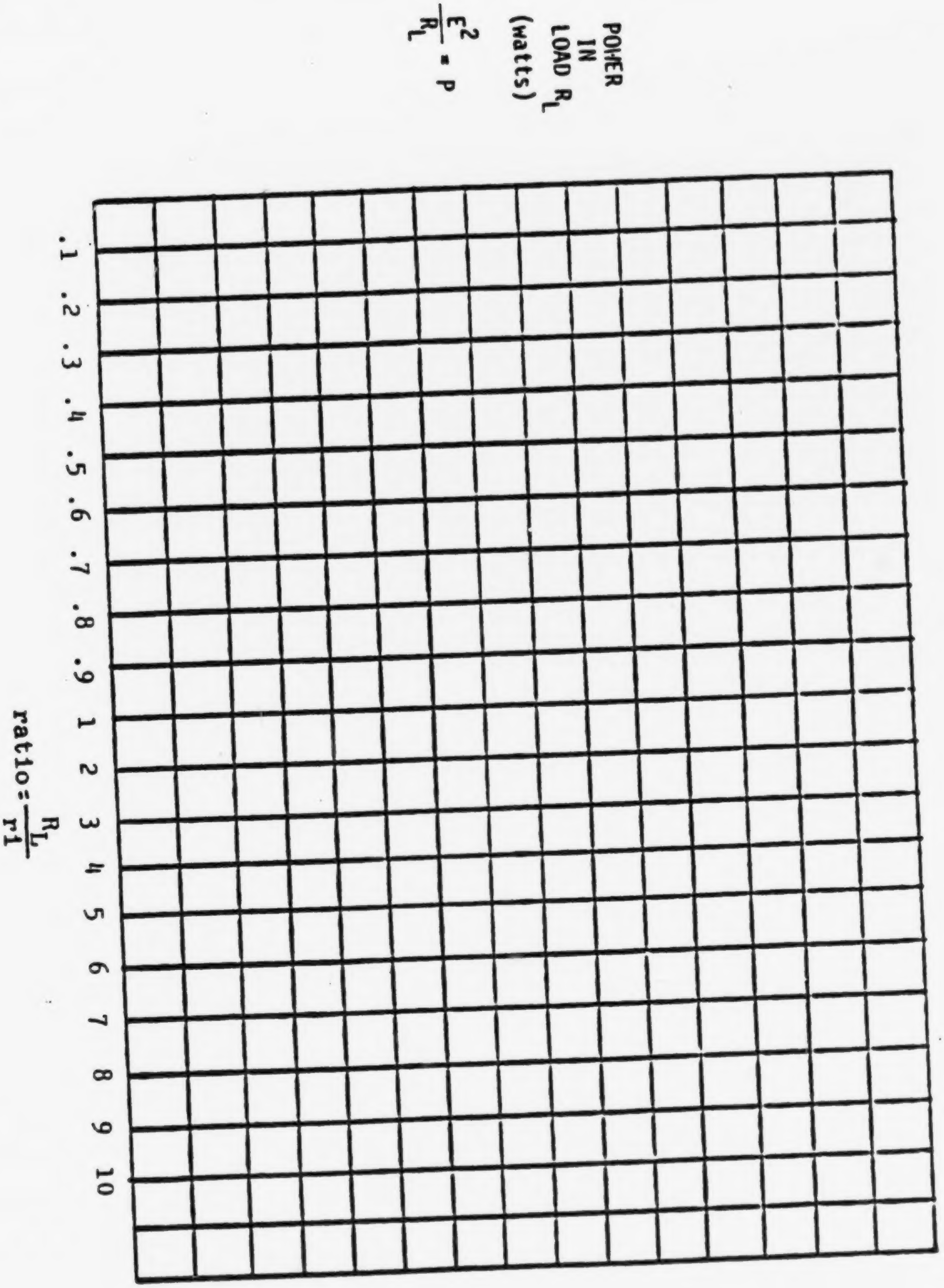
a. .00007 ohms
b. 6.67 ohms
c. 15,000 ohms
d. 99,985 ohms
e. 100,015 ohms

Answers to PROJECT 8: Self Evaluation

1 a; 2 a; 3 b; 4 c; 5 c;
6 b; 7 c; 8 d; 9 a; 10 d.

Your score: __________

How did you do? Wonderful OK Need to study more


POWER IN LOAD R_L (watts)
$\frac{E^2}{R_L} = P$
.1 .2 .3 .4 .5 .6 .7 .8 .9 1 2 3 4 5 6 7 8 9 10
ratio= $\frac{R_L}{r1}$

GLOSSARY

ELECTRONICS

TECHNICAL VOCABULARY

SERIES PARALLEL CIRCUITS

complex circuits
combination circuit analysis
junction
peg
unloaded
voltage dividers
considerable emphasis
dashed lines
phenomena
internal resistance
power source
external circuit
simulate
decade box
impedance
power in load
proposed shunt
scale deflection
wattage rating

GLOSSARY

ELECTRONICS

RELATED GENERAL VOCABULARY

SERIES PARALLEL CIRCUITS

be treated as
are added to
exceeded
laboriously
practice
prevent
undesirable effects
previous
principle
upcoming
reference
ratio values
occurs
that is
analog
layout

COMBINATION

combination = mạch kết hợp gồm nối tiếp với song song.

Series-parallel Resistive circuit: điện trở mạch nối tiếp kết hợp với mạch song song (combination)

frequently: Thường đến; thường xảy ra; luôn có; thường.

particularly: riêng biệt

motor: động cơ; mô tơ; máy phát động (biến đổi điện năng thành cơ năng).

equipment: dụng cụ; đồ dùng.

schematic diagram: sơ đồ về cấu tạo mạch điện bằng ký hiệu.

relating: mối liên lạc.

concept: ý niệm; quan niệm.

Reduce: giảm; bớt.

previously: phía trước; ở trước.

junction: chỗ nối nhau.

insert: xen vào; đẩy vào

variation: sự thay đổi.

error: sai lầm; nhầm lẫn

tolerence: sai biệt

possible: có thể được; xảy ra được

leg: chân (điểm nối)

- Chú ý: trong mạch combination tổng điện trở bằng điện trở tương đương của mạch song song (áp dụng các phương pháp tính điện trở của mạch song song) cộng với các điện trở ở mạch nối tiếp.
- Cường độ nguồn điện bằng cường độ xuyên qua một điện trở mạch nối tiếp và bằng cường độ tổng của mạch song song.

串並联电阻电路（SERIES-PARALLEL RESISTIVE CIRCUIT）.

combination：合併、配合

frequently：通常，经常

particularly：特别是

diagram：略图.

computation：計算

understanding：了解.

complex：複雜的.

concept：概念

reduced：減少；簡化了.

treated：对待、處理

equivalent：相等的.

previously：前面的，从前的

allowing：允許、容許.

junction：结連、交接点.

adjust：調整

leg：支柱、脚，引线，支线.

ELECTRON URRICULUM
VOCATIONAL TRAINING SSON PLAN #______ Magnetism

Teaching Materials Source ____________________
Chapter ____________, pages ____________
Lab Manual pages ____________
Additional Instructor Materials ____________________

Main concepts student will learn:

The student will be able to:

1. state the properties of magnetism and list ten electrical or electronic devices which utilize magnetism in one form or another.
2. identify the characteristics of magnetic lines of flux, and when given a magnet with the pole polarity labeled, indicate the direction of the lines of flux, both internal and external.
3. explain the basic laws of magnetism related to the poles of a magnet, and describe the earth's magnetism in reference to its geographical poles.

Length of Lesson

1 week

Evaluation

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of oral or written testing procedures.

Technical Vocabulary

see Glossary

Related General Vocabulary

Materials and Notes

Teaching Activity

1. When demonstrating magnetic lines or flux with a magnet and iron filings to be careful not to use an excessively strong magnet. Too intense of a magnet will not perform adequately because it forces the filings into groups rather than a uniform pattern.
2. To obtain inexpensive magnets for classroom demonstrations, consider government surplus stores as a prime vendor.
3. When discussing temporary magnets and their characteristics, many instructors will describe electromagnets as the major sub-category. Many electromagnets can and should be demonstrated along with inexpensive devices such as relays, electric bells, and solenoids.

Name: ____________________

Date: ____________________

MAGNETISM

Period: ____________________

TECHNICAL GLOSSARY

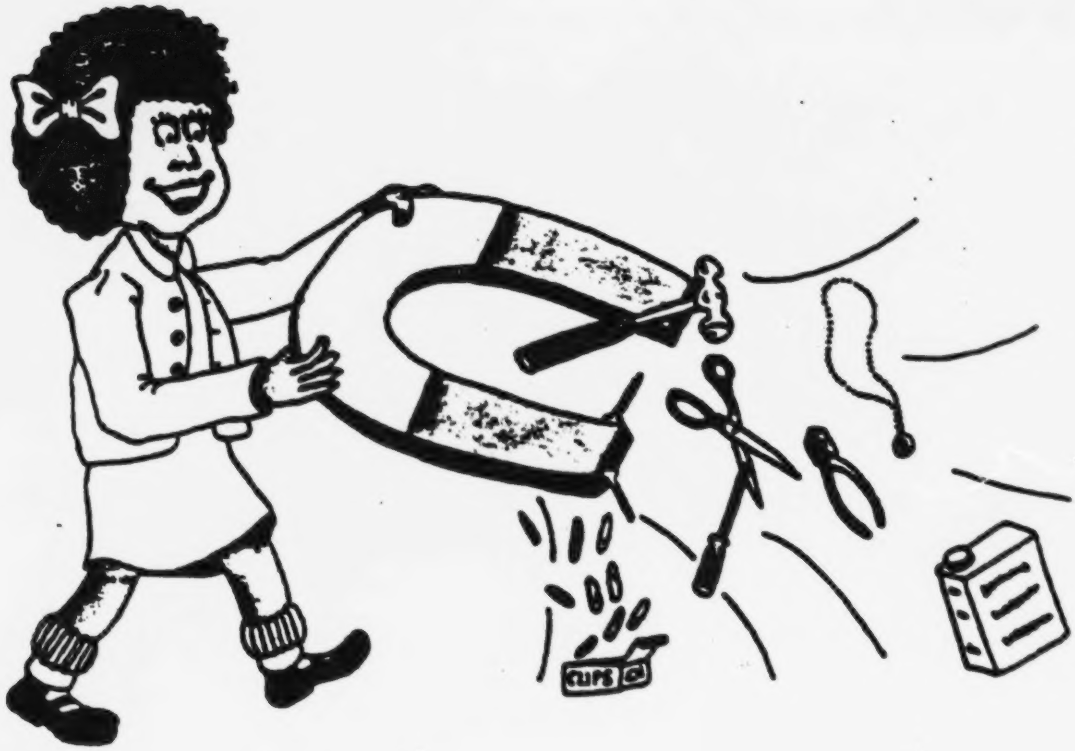
ATTRACT:	The process of drawing or pulling toward an object. For example; a magnet will attract a piece of soft iron.
BASIC LAW OF MAGNETISM:	A law that explains the interaction of magnetic fields. The law states: Like poles repel and unlike poles attract
COMPASS:	A device which utilizes the earth's magnetic field, and a pivoted magnet needle to indicate direction.
FERROMAGNETIC MATERIAL:	A classification for materials which are attracted by a magnet. These magnetic materials include iron, nickel, cobalt, etc.
FLUX LINES:	The lines of magnetic force which exist around a magnet.
GEOGRAPHIC POLE:	The axis points of the earth, such as the geographic south pole.
KEEPER:	A piece of soft iron placed across the poles of a magnet to confine the magnetic field within the magnet, and to avoid demagnetizing.
MAGNET:	A piece of iron, or a special alloy, which exerts an invisible force of attraction on materials such as iron, nickel, or cobalt.
MAGNETIC FIELD:	The space around a magnet which is influenced or affected by its magnetic force.
MAGNETIC NORTH POLE:	One of the earth's two magnetic poles. The earth's magnetic north pole is located approximately 1,000 miles south of the geographic north pole in northern Canada. The magnetic south pole is actually some 1,500 miles from the geographic south pole on the continent of Antartica.
MAGNETIC POLE:	The portion of a magnet where the lines of force are most concentrated. In every magnet there is one north-seeking pole (N-pole), and one south seeking pole (S-pole)
MAGNETIC SHIELD:	A magnetic material used to route magnetic lines of force around an object. This prevents the object from being affected by the magnetic field.
MAGNETISM:	The invisible force, exerted by a magnet, that allows it to attract ferromagnetic materials, and to attract or repell other magnets or magnetic fields.
AGNETITE:	A blackish iron ore which in its natural state contains magnetic particles within the material. Once these particles are aligned, the material will become magnetic and attract other ferromagnetic materials.

Name: ____________________

Date: ____________________

Period: ____________________

NATURAL MAGNET:	A material, such as "lodestone" or "magnetite," which in its natural state exhibits the qualities of a magnet.
PERMANANENT MAGNET:	A man-made magnet which when magnitezed will retain its magnetism. Steel or alnico are examples of material which can be made into permanent magnets.
REPEL:	The process of pushing away or forcing back of an object. A north pole of a magnet will repel the north pole of a second magnet.
TEMPORARY MAGNET:	A man-made magnet that loses its magnetism soon after the magnetizing force is removed. Magnetized soft iron is an example of a temporary magnet.



SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

VOCABULARY WORD DECODING

The words below have little meaning until they are decoded. Each letter actually represents another letter in the alphabet. Your task is to break the code and decode each word. The example will get you started by providing three decoded letters. The code remains the same throughout the worksheet.

EXAMPLE: A.	C E D M A N	A.	MAN
1.	G L Z D S I _ _ _ _ _ _	1.	
2.	G L Z D S I T N G _ _ _ _ _ _ _ _ _	2.	
3.	L A G C E N N _ _ _ _ _ _ _	3.	
4.	E R R K E L R _ _ _ _ _ _ _	4.	
5.	K S C S J _ _ _ _ _	5.	
6.	M S S C S K _ _ _ _ _ _	6.	
7.	D A K R N _ _ _ _ _	7.	
8.	C S I G L D S D R _ _ _ _ _ _ _ _ _	8.	
9.	V S K K A G E Z D S R T L _ _ _ _ _ _ _ _ _ _ _ _ _	9.	
10.	G E Z D S R T R S _ _ _ _ _ _ _ _ _	10.	
11.	R S G C A K E K P _ _ _ _ _ _ _ _ _	11.	
12.	G E Z D S R T L N W T S J O _ _ _ _ _ _ _ _ _ _ _ _ _ _	12.	

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

QUEST ACTIVITY

"UNIT 5"

MATCHING

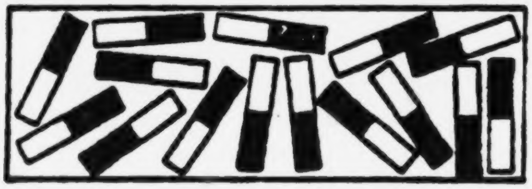
Match the term with the appropriate statement.

1. Lodestone
2. Compass
3. Repel
4. Ferromagnetic Material
5. Magnetizing
6. Attract
7. Magnetic Field
8. Magnetic Shield
9. Demagnetizing
10. Temporary Magnet

A. A suspended magnetic needle.
B. The total area around a magnet which contains flux lines.
C. Two N-poles brought close together.
D. Electromagnet or soft iron.
E. A natural magnet.
F. Nickel
G. Striking or heating a magnet.
H. One N-pole and one S-pole brought close together.
I. A soft iron material used to route flux lines around an object.
J. Drawing a permanent magnet along a steel bar.

1. ☐
2. ☐
3. ☐
4. ☐
5. ☐
6. ☐
7. ☐
8. ☐
9. ☐
10. ☐

11. The drawing below shows an unmagnetized steel bar. Using the area provided, make a sketch showing the change in position of the "magnetic molecules" to form a magnetized piece of steel.



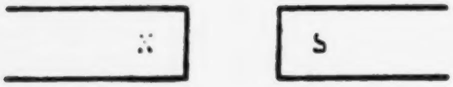
Name: ____________________

Date: ____________________

Period: ____________________

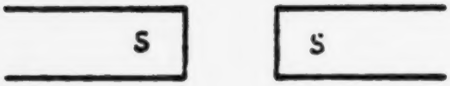
12. Draw a sketch of the magnetic field which surrounds the bar magnet below.

13. Draw a sketch of the field produced by the two magnets below.



Does this field produce attraction or repulsion?

14. Draw the field produced by the two magnets pictured below.



Does this field produce a force of attraction or repulsion?

15. List three practical uses for magnets or magnetic fields.

1.

2.

3.

Name: ____________________

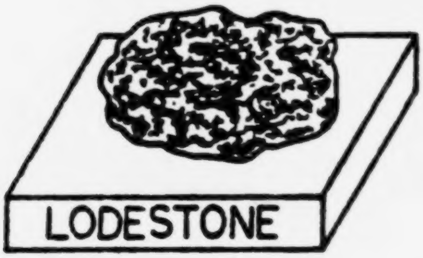
Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

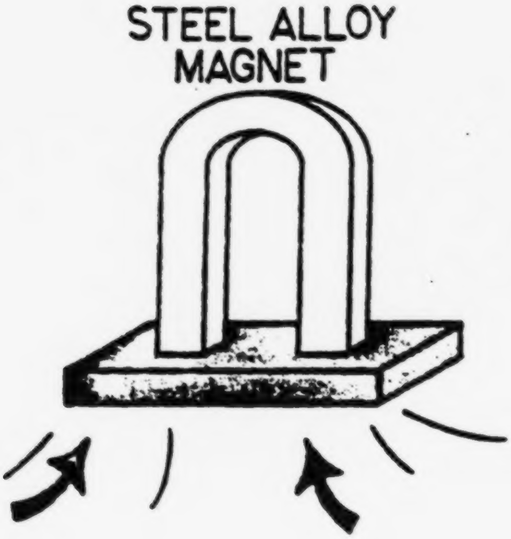
CLASSIFICATION OF MAGNETS

Any magnet can be classified as either natural, temporary, or permanent. Study each classification described below and the corresponding description.



NATURAL

A natural magnet needs no special treatment by people to make it magnetic. Lodestone (or magnetite) is a natural magnet found on the earth. Especially large quantities can be found in the United States, however, these magnets are very weak and really serve little purpose in the modern world.



PERMANENT

A permanent magnet keeps its magnetism for a long time. This type of magnet is produced from magnetic materials and can be made in a wide variety of shapes and sizes. They are used frequently in electrical appliances, hardware items, and compasses. The term artificial magnets is sometimes used to describe either permanent or temporary magnets, but what it really means is that the magnet is "man made."

Name: ____________________

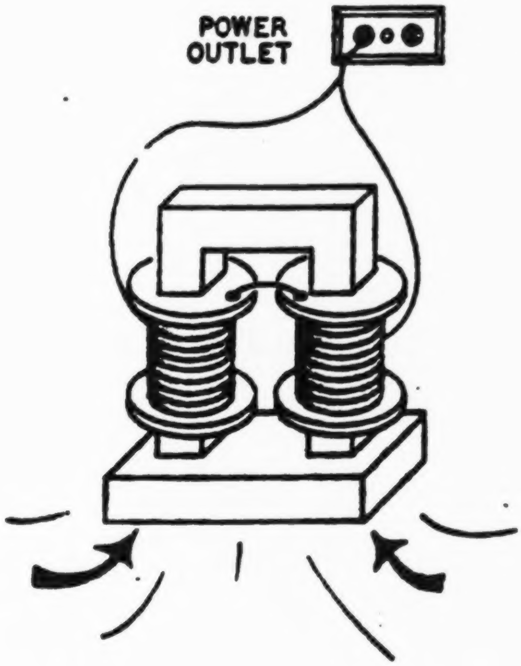
Date: ____________________

Period: ____________________

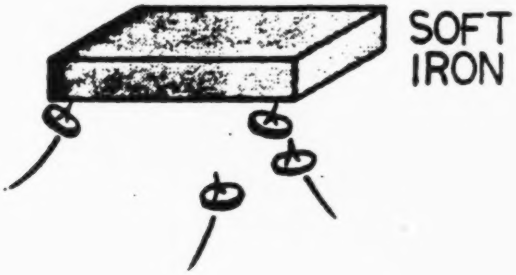
TEMPORARY

Temporary magnets are generally of two varieties, those made of material that do not keep their magnetism long (soft iron) and those which operate with the help of electricity (electromagnets). Electromagnets are temporary in that when electricity is applied they act like a magnet however, when the electricity is removed they do not retain their magnetism.

ELECTROMAGNET



OR



Name: ____________________

Date: ____________________

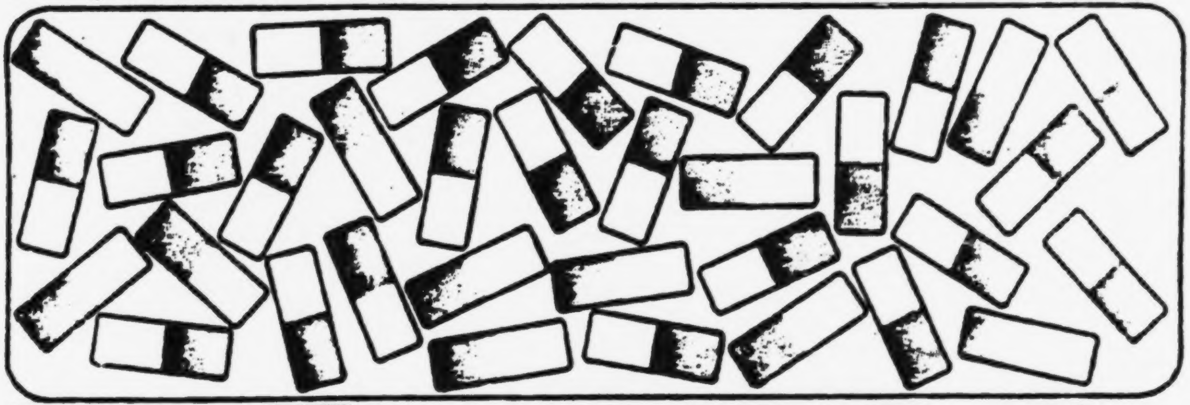
Period: ____________________

INFORMATIONAL HANDOUT

MAGNETISM AND MAGNETIC FIELDS

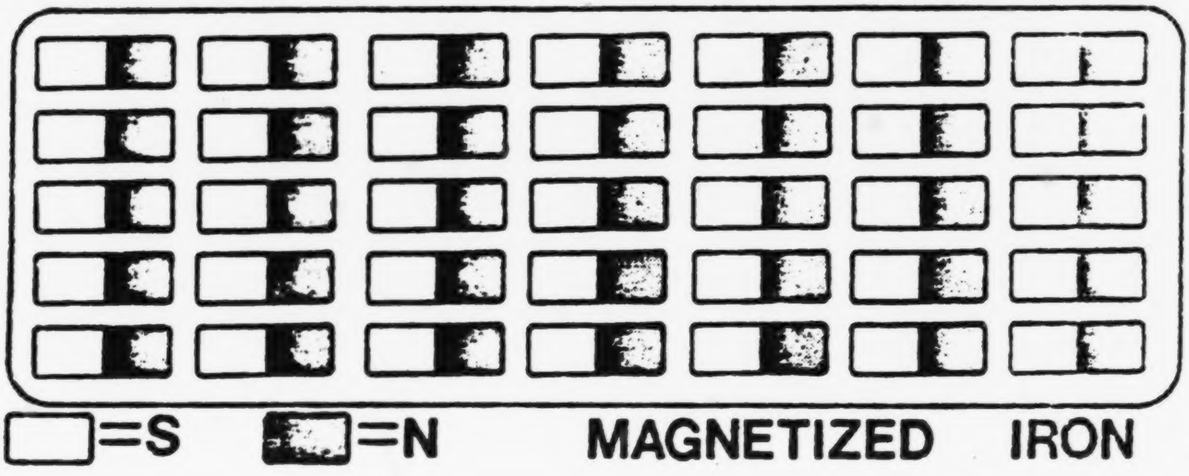
THE PHYSICS OF MAGNETIC MATERIALS:

Only certain materials have the ability to be magnetized, or to be attracted by a magnetic field. Natural magnetic materials are called ferromagnetic materials and include the elements iron, nickel, and cobalt. The atoms of these three materials have the peculiar ability to orient themselves so that each atom has a definite positive and negative side. These atoms combine to form magnetic molecules or domains, each small molecule has a north and south pole. In an unmagnetized piece of iron, for example, these magnetic molecules arrange themselves in a random pattern as shown below.



☐=S ▨=N **UNMAGNETIZED IRON**

When a material is magnetized, either by contact, or by being placed within a DC electromagnetic field, the magnetic molecules are forced to move and align themselves in one direction as shown below.



☐=S ▨=N **MAGNETIZED IRON**

✓

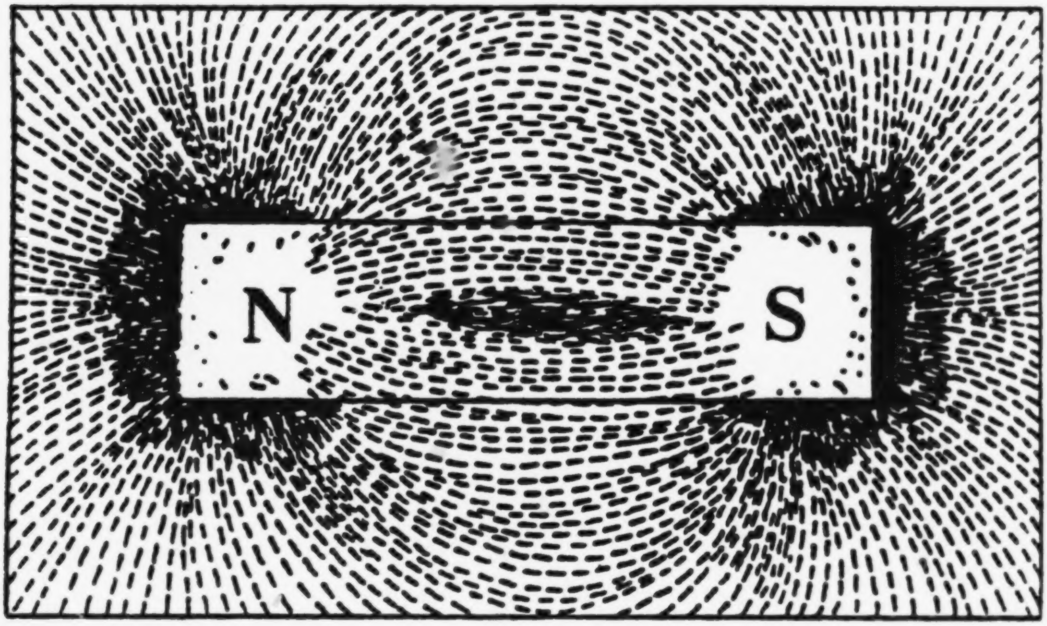
Name: ________________

Date: ________________

Period: ________________

MAGNETIC FIELDS:

The magnetic field of a magnet is made up of a number of invisible lines of force known as flux lines. These flux lines extend from the magnetic poles out into space, flowing from the N-pole to the S-pole, and not crossing or touching. As the distance from the magnet increases, the separation between the flux lines becomes greater, and the field becomes weaker. The strongest concentration of flux lines is located at the poles of the magnet. Study the diagram of the bar magnet and its associated magnetic field below. Locate the magnetic poles, and the areas of dense flux concentration.



Magnetic Field

NOTES:

Name: ____________________

Date: ____________________

Period: ____________________

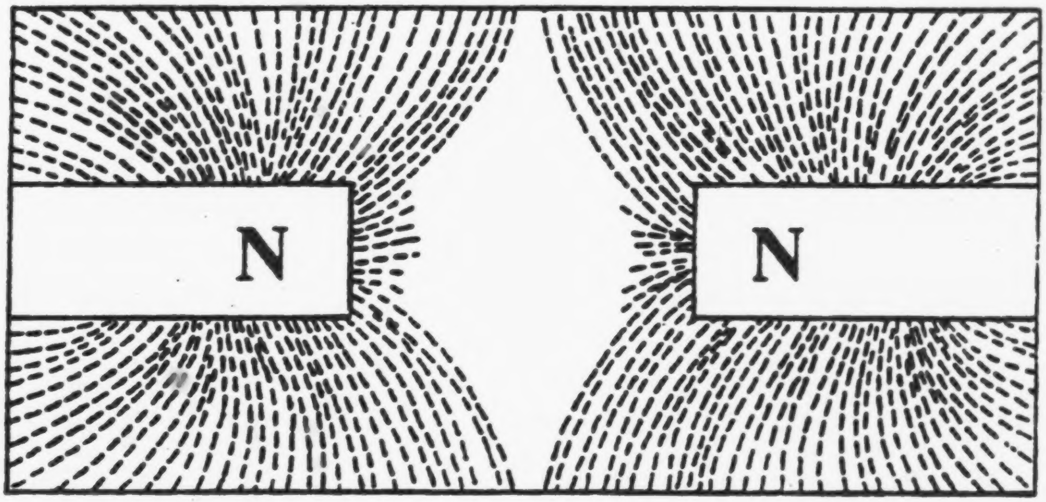
BASIC LAW OF MAGNETISM:

As you probably know from common experience, when two magnets are brought close to each other they will either pull together (attract), or push apart (repel). The action of the two magnets will depend upon the orientation of the magnetic poles. The basic law of magnetism explains the magnetic reaction in this way:

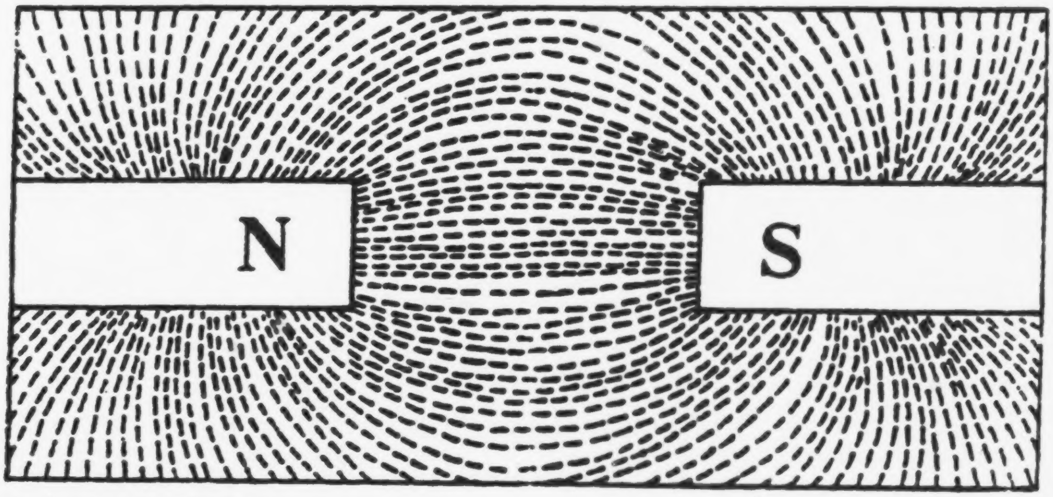
Like poles repel - (N-pole and N-pole repel as well as S-pole and S-pole)

Unlike poles attract - (N-pole and S-pole attract)

Fields of magnetic attraction and repulsion are shown below:



Magnetic Repulsion



Magnetic Attraction

Name: ____________

Date: ____________

Period: ____________

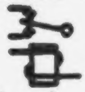
TECHNICAL GLOSSARY

ATTRACT:	The process of drawing or pulling toward an object. For example: a magnet will attract a piece of soft iron.
BELL:	Basically a buzzer with a hammer added to the moving end of the armature. The hammer is designed to strike a bell or gong each time the armature moves toward the electromagnet. The electric bell is one of the oldest household appliances.
BUZZER:	An electromagnetic device which includes a flexible armature, and a switching mechanism. The armature is first attracted to the energized electromagnet. At a certain point, the moving armature causes a switch contact to open, turning off the magnetic field, and allowing the armature to be pulled back by a spring. This reverse motion closes the switch to reenergize the electromagnet and again attract the armature. This process is reapeated over and over again, creating a buzzing sound.
CORE:	The center of a wire coil, which can act as a "form" for the wrappings of wire. The core is used to provide a magnetic path for flux lines, and is commonly made of soft iron, or laminated sheets of iron. Many coils do not use an iron or metal core, but rather use plastic or cardboard tubes; this type of coil is called an air core coil.
ELECTROMAGNET:	A coil of insulated wire wrapped around a soft iron core which becomes magnetic when a current is forced through it. The core acts to concentrate the magnetic line of force. And becomes magnetized when current flows through the coil.
ELECTROMAGNETISM:	The magnetic effect produced when electrons flow through a wire or coil. This invisible field produces both a north and south magnetic pole, similar to a permanent magnet. The strength of this field depends upon the magnitude of the current flow, the number of turns of wire in the coil, and the type of core used. If the current flowing through the wire or coil is stopped, the magnetic effect ceases.
FERROMAGNETIC MATERIAL:	A classification for materials which are attracted by a magnet. These magnetic materials include iron, nickel, cobalt, etc.
FLUX LINES:	The lines of magnetic force which exist around a magnet, also known as "Lines of force."

Name: ________________

Date: ________________

Period: ________________

LEFT-HAND RULE:	A method used to determine the polarity of the electromagnetic field surrounding a single conductor or a coil. In the case of a single conductor, the left thumb points in the direction of electron flow, while the fingers, curled around the wire, indicate the direction of the flux lines. To use the left-hand rule for a coil, wrap the fingers of the left-hand around the coil in the direction of current flow; the thumb will then be pointing toward the coil's north pole.
LIFTING MAGNET:	A very strong electromagnet, commonly used for moving scrap steel. The advantage of the lifting magnet is that the magnetic field can easily be switched on and off.
MAGNETIC FIELD:	The space around a magnet or electromagnet which is influenced or affected by its magnetic force.
MAGNETIC POLL:	The portion of a magnet where the lines of force are most concentrated. In every magnet there is one north-seeking pole (N-pole), and one south-seeking pole (S-pole)
MAGNETISM:	The invisible force, exerted by a magnet, that allows it to attract ferromagnetic materials and to attract or repell other magnets or magnetic fields.
PERMEABILITY:	A measure of how easily magnetic lines of force can pass through a material.
RELAY:	An electrical device, basically a switch, controlled or turned on and off by an electromagnet. Generally, the current flowing to the electromagnet is controlled by a separate circuit. Relays are used in several electronic devices, but they are slowly being replaced by modern solid state switching devices. Symbol:  Letter symbol: K.
REPEL:	The process of pushing away or forcing back of an object. A north pole of a magnet will repel the north pole of a second magnet.
RESIDUAL MAGNETISM:	The magnetism remaining in a material or magnetic core after the magnetizing force is removed. The ability of a material to retain magnetism is referred to as retentivity.
SOLENOID:	A cylindrical electromagnet made with a movable iron core or plunger. When the electromagnet is energized, the plunger is sucked or drawn into the center of the coil. A spring will pull the plunger partially out of the coil when the circuit is denergized. The pulling force of a solenoid can be strong enough to operate switches, locks, valves, or door chimes. Solenoids are also known as sucking coils.

Name: ____________________

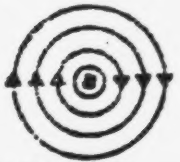
Date: ____________________

Period: ____________________

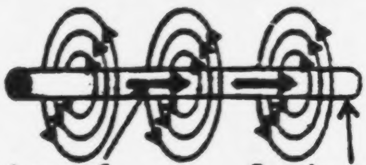
INFORMATIONAL HANDOUT

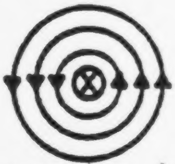
ELECTROMAGNETIC FIELDS

THE MAGNETIC FIELD AROUND A SINGLE CURRENT CARRYING CONDUCTOR:



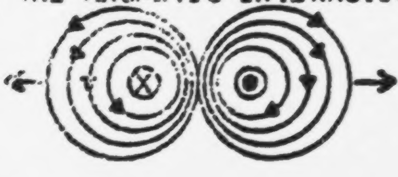
Cross-section drawing of a conductor and magnetic field showing current flowing toward you (•).



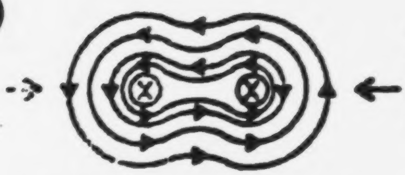


Cross-section drawing of a conductor and magnetic field showing current flowing away from you (X)

THE MAGNETIC INTERACTION OF TWO PARALLEL CURRENT CARRYING CONDUCTORS:

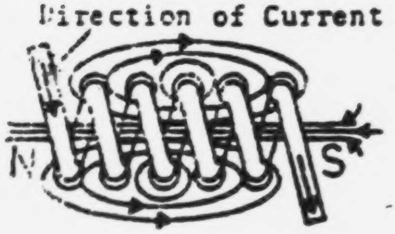


When two parallel wires carry opposite currents, opposite electromagnetic fields are developed. These fields with opposite polarities will repel each other.



When two parallel wires carry a current flowing in the same direction, similar electromagnetic fields are developed. Flux lines flowing in the same direction join, or add, causing attraction.

THE MAGNETIC FIELD SURROUNDING A CURRENT CARRYING COIL:



Around a coil, the flux lines are all flowing in the same direction, thus adding together creating a stronger field. The strongest concentration of flux lines will be located within the center or core of the coil.

INCREASING THE STRENGTH OF AN ELECTROMAGNETIC FIELD:

- Increasing current flow through a wire or coil will result in the strengthening of the field.
- The addition of more turns of wire to a coil, or wrapping the wires closer together will also cause an increase in magnetic strength.
- Including a soft iron core within the coil will tend to concentrate the magnetic flux lines and produce a stronger field. Thus, the type of core used in the electromagnet will affect its strength.

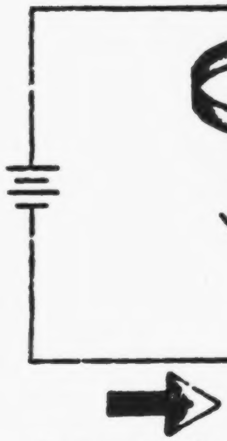
Name: ____________________

Date: ____________________

Period: ____________________

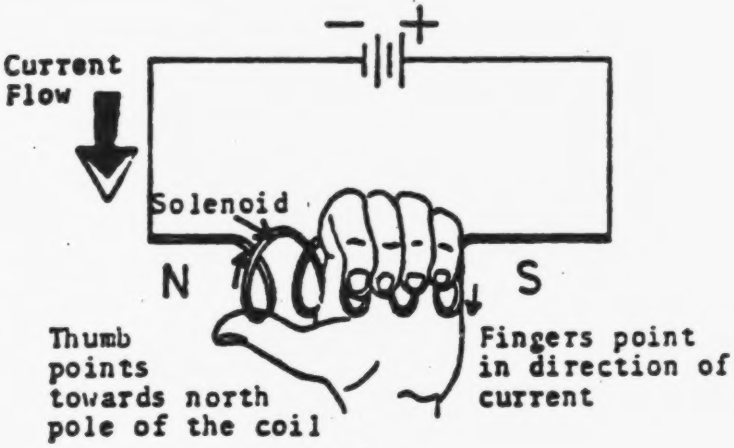
THE LEFT-HAND RULE:

This form of the left-hand rule is used to determine the direction or polarity of the magnet fields formed around a single conductor or coil.


Current Flow

To use the-left hand rule for a single conductor, point your left thumb in the direction of current flow; your fingers will then wrap around the wire pointing in the same direction as the magnetic field.

LEFT HAND RULE


−
+
Current Flow
Solenoid
N
S
Thumb points towards north pole of the coil
Fingers point in direction of current

When using the left-hand rule for coils or solenoids, simply wrap your fingers around the coil in the direction of current flow; the left thumb will point toward the north magnetic pole of the coil.

SCORE:

GRADE:

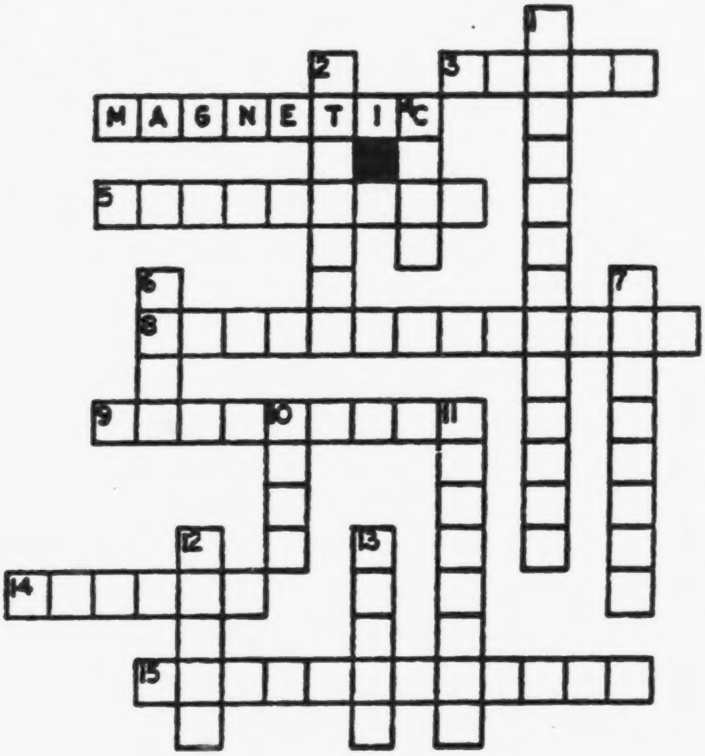
Name: ______________

Date: ______________

Period: ______________

WORKSHEET

VOCABULARY - CROSSWORD



ACROSS

3. The space around a magnet which is influenced by its magnetic force.

5. A type of magnet which loses its magnetism very rapidly once the magnetizing force is removed.

8. A type of magnet which requires a coil of wire, soft iron core, and electric current.

9. The invisible lines of force surrounding a magnet.

14. Electromagnetic device which utilizes flexible, vibrating armature.

15. A measurement of the ease at which flux lines move through a material.

DOWN

1. Materials which are readily attracted by a magnetic field.

2. To draw or pull toward an object.

4. Center of a wire coil.

6. One of the oldest household electronic appliances.

7. The magnetism retained by the soft iron core of an electromagnet.

10. A method used to determine the polarity of an electromagnetic field, known as the __________ hand rule.

11. Sucking coil.

12. The opposite of attract.

13. An electromagnetic switch.

SCORE:

GRADE:

Name: ____________________

Date: ____________________

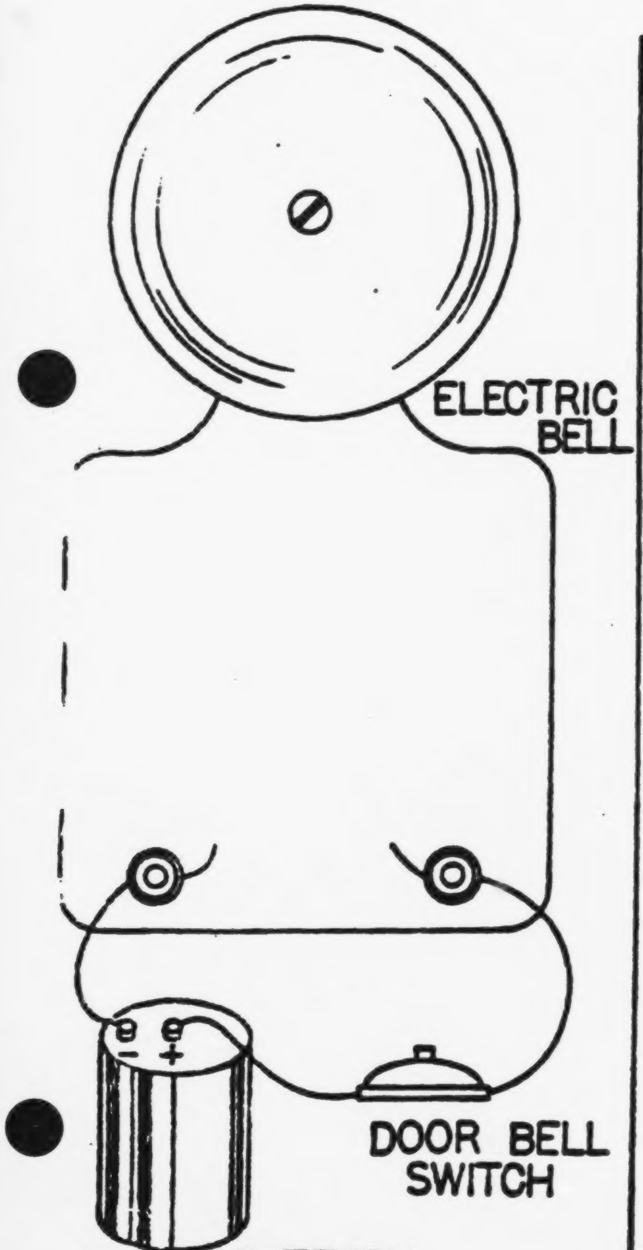
Period: ____________________

WORKSHEET

QUEST ACTIVITY

"UNIT 14"

omplete the drawing of the electric bell, by sketching and labeling the emaining internal and external parts; be complete and accurate. Next, describe in detail the electrical operation of the device - be specific.


ELECTRIC BELL
-
+
DOOR BELL SWITCH
BATTERY

Electrical Operation:

EXPERIMENT

Experiment #1

MAGNETIC FIELDS

MATERIALS:

two bar magnets
two horseshoe magnets with keepers, paper, and iron filings
stirrup and thread
petri dish

PROCEDURE:

1. Place the bar magnets so that the N pole of one is near, but not touching, the S pole of the other. Put a sheet of paper over the magnets and sprinkle iron filings over the paper. Gently tap the paper. Observe how the iron filings tend to form lines. Draw a diagram of these lines of force.

2. Bring the two south poles near and put a paper over the magnets. Again sprinkle iron filings over the paper and tap it. Observe the lines of force this time. Draw a diagram. Repeat with the two north poles near.

Experiment #1, con't

3. Repeat the experiment with the horseshoe magnets, first with unlike poles close, and then with like poles close but not touching. Sketch each.

4. Use one horseshoe magnet with the keeper close to, but not touching, the magnet.and the keeper and gently sprinkle the iron filings on the paper. Observe how the lines of force go through the keeper. Sketch the magnet, keeper, and lines of flux.

5. Lay a bar magnet on a sheet of paper. Using a small compass, place it in several positions around the magnet. Draw a short line next to the compass to indicate the direction of the needle. You can connect the short lines to give the directions of the lines of force around the magnet. Because additional lines of force will be symmetrical about the magnet, finish your sketch by supplying these lines in the places about the magnets where you think the lines of magnetic flux should go.

EXPERIMENT #2

MAKING PERMANENT MAGNETS

MATERIALS:

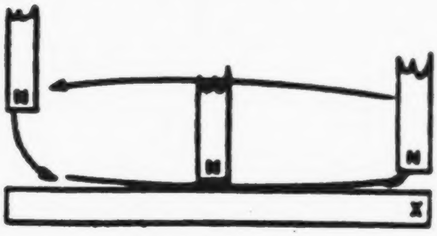
2 bars or rods of steel
large needles
compass
insulated copper wire
dry cell
breaking magnet

1. Bring the north pole of the permanent magnet near the compass. Which pole of the compass is attracted?

2. Repeat using the south pole of the magnet. Which pole of the compass is attracted?

3. Mark the ends of the bar of steel or use the large needle. Bring one end of the bar of steel to first the north pole of the compass and then to the south pole. Mark down what happens.

   Use the north pole of the permanent magnet to stroke the bar of steel, going in only one direction. After stroking several times, check to see if the steel is a magnet, and, if so, which end is N, and which end S?



motion of stroking

4. Wrap the wire around the bar of steel and connect the wire to the dry cell for a couple of seconds. Test the bar with the compass to see if it has become a magnet. Check with the instructor if it does not become magnetized.

EXPERIMENT #3

TEMPORARY MAGNETS

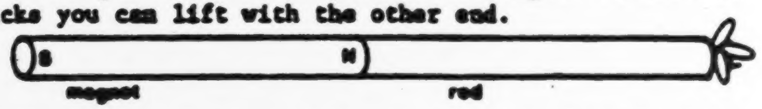
MATERIALS:

soft iron rod
insulated copper wire
2 dry cells
2 permanent magnets
hammer
compass
tacks or small nails

PROCEDURE:

1. Check the iron rod with the compass to see that it is not a magnet. Wrap the wire around the rod and connect the wire to the dry cell, and see how many tacks you can lift with the temporary magnet. Disconnect the dry cell and the tacks will fall. Put more coils of wire around the rod and you will be able to lift more tacks. If you connected two dry cells in series, you will increase the magnetic field and attract more tacks.

2. Take the iron rod and place the north pole of the magnet to one end. See how many tacks you can lift with the other end.



Next put the south pole to the end of the rod. The number of tacks should be about the same. Is it?

Put the two magnets side by side with north poles to the south poles, and place one end to the end of the iron rod. You will pick up fewer tacks than before. Now place the magnets side by side again, but with the north poles together. Place the north poles to one end of the rod, and you will pick up many more tacks than with only one magnet.

3. Hold the soft iron rod in the direction of the earth's lines of force and tap it a few times with the hammer. Test the rod to see if it is now a weak magnet.

INFORMATION SUMMARY

Nickle and cobalt are materials along with iron and steel that are affected by magnets and the associated magnetic fields of flux. These materials are attracted by magnets and can be magnetized.

Both permanent and electromagnets can vary in strength, and the strength of such magnets determines how great a distance the influence of the magnetic field extends. The relationship between field strength and distance states that the field strength varies inversely as the square of the distance.

field strength $\propto \frac{1}{d^2}$; that is, if you cut the distance to

½ what it was, the field strength is 4 times as great.

There are materials such as glass, copper, and aluminum that do not change the shape or configuration of the magnetic field; that is, they are magnetically transparent. Other materials such as iron and nickle seem to attract and channel the magnetic field through them. Actually the lines of flux or force move more easily within the metal itself than through the air.

EXPERIMENT

Experiment I

MATERIALS:

Electromagnetic coil
Pieces of iron, steel, cobalt, nickle, and iron filings

PROCEDURE:

Place each of the metals in the electromagnetic coil and check with the iron filings to see if they became magnets. You will find that cobalt and nickel became magnets also, but not as strong as iron and steel.

EXPERIMENT

Experiment II

MATERIALS:

Electromagnetic coils
2 permanent magnets
tack or small nails
iron rod
stirrup
thread
cores for the electromagnets

PROCEDURE:

1. Take one of the magnets and see how many tacks you can pick up. Then place the magnets side by side with the north and south poles together. Compare the number of tacks you can pick up. Now place the magnets so the north poles are together and the south poles are together. Compare the number of tacks you can pick up.

2. Take an electromagnet (without core) and see how many tacks can be picked up. Increase the number of coils and compare the number of tacks. Increase the amperes and compare the number of tacks. Now place a core in the original coil and again check the number of tacks that can be picked up. List the number of tacks in each case.

3. Hang an iron rod in a stirrup suspended on a thread. Bring one magnet, from the side, toward one end of the iron rod. Notice when it first attracks the rod. Measure this distance. Repeat several times, until you are sure you have the distance when it first is affected. Now place the two magnets together so that north is by north and repeat the experiment. (This can be repeated with three magnets.) Does the distance of the first affect decrease, increase, or stay the same?

4. The experiment in part three can be repeated using electromagnets.

EXPERIMENT

Experiment III

MATERIALS:

A set of six materials in sheet form, 8 cm square: glass, zinc, brass, aluminum, copper, and iron
A magnet
Iron filings

PROCEDURE:

Place the magnet in the center of each of the different materials one at a time and see if the magnet will pick up iron filings with the material always between the magnet and the filings.

5

LAB.: Electromagnetism and Relays

Name ______________________ **Date** ________ **Per.** ____

Problem 1

Design and construct a circuit using the relay that will turn on and off two lights with a single switch.

Points ______________________

Schematic Diagram

Signature ______________________

Problem 2

Design and construct a circuit using the relay that uses one switch to control two lights. Each light should switch on and off but when one light is on the other light should be off.

Points ______________________

Schematic Diagram

Signature ______________________

Problem 3

Design a circuit like problem #1 but the switch will now activate a relay and the relay should control the lights.

Points ______________________

Schematic Diagram

Signature ______________________

Problem 4

Design a circuit like problem #2 but the switch will now activate a relay and the relay should control the lights.

Points ______________________

UNIT EXAM

Magnetism

IMPORTANT-

INDICATE YOUR RESPONSES ON THE ANSWER SHEET ONLY. Fill in the box corresponding to the correct answer to each question, there is only one correct answer for each question.

1. Copper, aluminum, and steel are magnetic materials. (T - F)

2. A permanent magnet is one that connot be destroyed or weakened. (T - F)

3. It is never necessary or desirable to demagnetize a material or object. (T - F)

4. Alnico is a natural magnet. (T - F)

5. Most metallic materials exhibit magnetic properties. (T - F)

6. As magnetic poles are moved apart, the magnetic force of attraction or repulsion decreases. (T - F)

7. Heating, striking, or placing a magnet within an alternating current field will increase its magnetic strength. (T - F)

8. Magnetic flux lines "flow", or extend from the N-Pole to the S-Pole. (T - F)

9. The earth's magnetic field is similar to the field developed by a bar magnet. (T - F)

10. The needle of a compass points toward the earths geographic north pole. (T - F)

11. Ferromagnetic materials are those materials which are attracted by a magnet. (T - F)

12. Flux lines are also known as lines of force. (T - F)

Name________________________________

13. Because flux lines do not have north and south poles, a compass cannot be used to determine that they do exist around a current carrying conductor. (T - F)

14. The iron core of the electromagnet does not affect the strength of the magnet. (T - F)

15. Like poles repell while unlike poles attract each other. (T - F)

16. A magnetic field is made up of visible flux lines. (T - F)

17. A solenoid is an electromagnet with a movable iron core. (T - F)

18. Permeability is the measure of how long a magnet will remain magnetized. (T - F)

19. An electromagnet is a type of permanent magnet. (T - F)

20. A relay is basically an electromagnetic switch. (T - F)

21. Electromagnetism is an invisible force which attracts any metal. (T - F)

22. A temporary magnet has high retentivity or residual magnetism. (T - F)

23. Magnetic lines of force that exist around a conductor are caused by current flowing in the conductor. (T - F)

24. Electromagnetism cannot be produced by using alternating current. (T - F)

25. Oersted discovered that an electric current flowing in a conductor will produce magnetism. (T - F)

26. Flux lines exist around a conductor at all times. (T - F)

27. The armature of the relay must be made of a ferromagnetic material. (T - F)

28. Increasing the current flow in a solenoid will increase the strength of the electromagnet. (T - F)

29. When using the left-hand rule for current carrying coils, the thumb POINTS IN THE DIRECTION OF THE NORTH POLE. (T - F)

30. Surrounding each magnet is:
(a) a negative charge, (b) a current, (c) a voltage,
(d) a magnetic field.

31. A magnet which keeps its magnetism for only a short time is: (a) a permanent magnet, (b) made of soft iron, (c) a temporary magnet, or (d) both b and c.

32. A magnetic field is thought to be made of:
(a) N and S Poles, (b) orbiting electrons, (c) flux lines,
(d) glass.

33. The basic law of magnetism states:
(a) unlike poles repel (b) like poles repel (c) two south poles attract (d) like poles attract.

34. Which pole of the magnet has the most strength?
(a) North Pole (b) South Pole (c) both have equal strength
(d) the strength will bary form magnet to magnet.

35. Which of the following operates by magnetic force or magnetism.
(a) electric motor (b) electric buzzer (c) solenoid
(d) all of the above.

36. Other than magnetic stroking, a steel bar can be magnetized by:
(a) placing it within an AC Field (b) striking it (c) heating it (d) placing it in a DC Field.

37. Flux lines around a current carrying conductor:
(a) have no particular shape (b) will appear at only certain places (c) form a circular pattern around the conductor
(d) have a North and South Pole.

38. When two conductors carry opposite currents:
(a) opposite electromagnetic fields are produced (b) similar electromagnetic fields are produced (c) no magnetic fields are produced (d) the two fields repell one another.

39. The left hand rule states that the thumb points to the North Pole when working with: (a) a coil (b) a straight wire (c) solenoid
(d) both A and C.

40. A material that has high retentivity can be used for:
(a) electromagnets (b) permanent magnets (c) temporary magnets
(d) paramagnets.

MAGNETISM

Magnet : nam châm

Magnetism : từ tính, tính hút của nam châm.

Magnetic (a) về nam châm.

The process : sự kiện.

Drawing : việc kéo

pulling : sự kéo vào

Toward : hướng về

Object : vật, đồ vật.

attract : hút } ở đây chỉ lực hút và đẩy của nam châm.

repel : đẩy

a piece of soft iron : . một thanh sắt non.
. một miếng vụn sắt.

Basic Law of magnetism: luật căn bản của nam châm.

magnetic fields: từ trường của nam châm.

interaction : chỉ hành động; hành động chung.

like : giống nhau.

unlike : khác nhau.

Like poles repel and unlike poles attract:
Cùng cực đẩy nhau và khác cực hút nhau (ý nói 2 đầu nam châm hoặc dương với dương (đỏ) hoặc âm với âm (đen) hay Bắc với Bắc và nam với Nam thì đẩy nhau. 2 đầu nam châm Bắc (N) với Nam (S) hay Nam (S) với Bắc (N) có nghĩa khác cực thì hút nhau.

Compass : địa bàn, la bàn.

Utilize : dùng; lợi dụng

Earth's magnetic field : từ trường của quả đất.

pivote : quay

magnetic needle : kim nam châm của la bàn

indicate : chỉ rõ

Direction : phương hướng

Ferromagnetic material : vật liệu có tính sắt từ tính.

I. M

classification: sự xếp lớp

classification for materials :
sự xếp lớp (loại) cho
các vật chất.

magnetic materials : . những vật
chất có từ tính.
- Từ vật.

Include : bao gồm; gồm.

iron : sắt.

nickel : kẽm

Cobalt : chất cobalt.

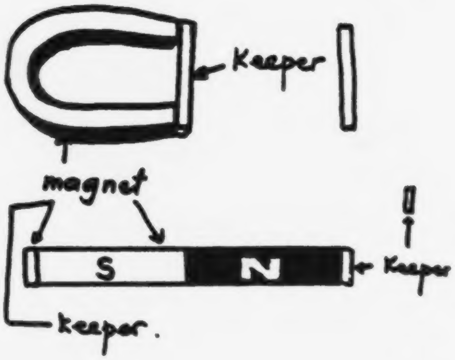
Flux lines : Các đường sức
-(từ lực).

magnetic force : từ lực

Exist : tồn tại; có

Geographic
Pole : - Cực địa lý.
- cực quả đất
(Cực nam và cực
Bắc).

Keeper : là một miếng sắt
non được ngang
qua 2 cực của
nam châm để
giữ từ trường của nam châm
ở trong nam châm để tránh
sự mất từ tính.



confine : giam giữ.

avoid : tránh.

demagnetizing : lìa khỏi tính
nam châm
(mất từ tính).

alloy : hợp kim

exert : ra sức, nỗ lực.

invisiable force : lực vô hình

influenced : Thế lực, ảnh hưởng

affect : ảnh hưởng

effect : tác dụng.

approximate : ước lượng; phỏng
độ; độ chừng.

geographic : (a) về địa dư,
địa lý.

2.M

actually	: thực sự, có thực
continent	: liên tục.
portion	: chỗ; vị trí; phần; đoạn; - chia ra.
concentrate	: tập trung
seeking pole	: cực của nam châm
north seeking pole (N pole); south seeking pole (S pole)	: cực nam và cực Bắc của Nam châm.
magnetic shield	: rổ nam châm dùng để ngăn cản hay bao bọc nam châm tác dụng đến vật có tính sắt từ tính.
prevent	: ngăn cản.
magnetite	: từ quặng
Blackish iron ore	: quặng sắt
natural state	: trạng thái thiên nhiên.
contain	: chứa đựng.
magnetic particles	: các phần tử nam châm.
particle	: phần tử
align	: xếp thành hàng
become	: trở thành, trở nên.
natural magnet	: nam châm thiên nhiên (nam châm lấy từ quặng, mỏ ở lòng đất tự nó có từ tính.
lodestone	: đá nam châm
Magnetite	: từ quặng; từ thạch.
exhibit	: trình bày; có đặc tính
quality	: tính chất
permananent magnet	nam châm vĩnh cửu
magnetized	luyện nam châm
retain	duy trì
steel	. chất thép
alnico	. chất alnico
push away	đẩy ra xa
forcing back	[illegible] ra xa

3. M

Temporary magnet : nam châm tạm thời. Người ta làm nam châm (nam châm nhân tạo) mà nam châm mất đi từ tính của nó ngay sau khi hủy luyện nam châm dời đi. Việc luyện sắt non là một thí dụ cho một thanh nam chân tạm thời (nhân tạo).

Until : đến khi

code : mật mã

decode : dịch ra chữ thường (phá vỡ mật mã)

remain : còn lại; thừa lại

Match : làm xứng bộ; thích hợp.

appropriate : riêng biệt.

appropriate statement : Câu riêng.

unmagnetized steel bar : thanh thép chưa luyện nam châm.

bar : thanh

Sketch : vẽ, phác họa

position : vị trí

magnetic molecules : những phân tử nam châm

Surround : chạy vòng quanh

attraction ≠ repulsion

sự hút ≠ sự đẩy

practical : thực dụng

describe : mô tả

corresponding : hợp với, tương ứng với

Description : sự mô tả

natural : thiên nhiên

temporary : tạm thời

permanent : [illegible]

treatment : [illegible]

Especially : [illegible]

weak [illegible]

strong [illegible]

real [illegible]

purpose : [illegible]

vary : đổi khác
variety (n) : -đổi khác (nhiều cỡ)
-tính biến hóa.
shape : kiểu ; thể
sizes : cỡ (nhiều cỡ lớn - nhỏ).
frequently : hay có luôn; thường xảy ra.
hardware : các hàng bằng sắt, thép; đồ dùng bằng sắt, thép.
item : món hàng.
artificial : nhân tạo
really : thực sự
generally : thông thường.
electromagnet : nam châm điện.
electrecity : điện lực
remove : dời đi
retain : giữ
Physic : vật lý.
certain : chắc chắn
material : vật liệu.
ability : năng lực
peculiar : đặc biệt.
peculiar abibity : năng lực đặc biệt.

orient : quay về hướng đông.
atom : nguyên tử
definite : xác định.
combine : kết hợp
domain # molecule : phân tử.
unmagnetized : không (chưa) luyện nam châm.
arrange : xếp đặt.
random : tình cờ.
pattern : đồ án
contact : giao dịch
extend : phát ra
Out into space (đi ra ngoài) vào trong không gian.
Separation : sự tách biệt.
associated : kết hợp, liên kết [illegible] giao
dense : dầy
orientation : sự định hướng
Bell : chuông điện.
buzzer : còi điện
Hammer : búa

5. M

Armature : phần ứng điện .
gong : cái chiêng .
appliance : dụng cụ; khí cụ; đồ dùng .
mechanism : sự cấu tạo .
energized : được kích thích .
allow : cho phép
spring : cái lò xo .
reverse : mặt trái; đảo ngược .
reenergize : đổi sự kích thích (lại kích thích).
creating : tạo nên .
core : lõi
wrappings of wire : quấn dây .
coil .(v) cuốn; bó (n) cuộn dây .
laminated : . được cán mỏng ra .(a) cán mỏng .
strength : cường lực; sức mạnh .
magnitude : sự oai nghi; vĩ đại .
ceases : ngừng; đình chỉ .
magnetic force : từ lực
exist : tồn tại
lines of force : đường sức .

6. M

Left-hand Rule: qui tắc bàn tay trái .
In the case of : trong trường hợp của ...
thumb : ngón tay cái
curled around : được cuốn tròn theo
lifting : nhấc lên .
scrap : mẩu
Can easily be switched : có thể dễ bật
Can pass through : xuyên qua .
Relay : bộ công tắc điện từ; kế điện .
Residual magnetism : từ dư .
remaining : còn lại
retain : duy trì, giữ lại .
regarded as : được biểu lộ; coi là; chỉ là; coi như .
retentivity : sự giữ lại .
solenoid ≠ relay : kế điện .
cylindrical (a) – cylinder : ống tròn, hình trụ .

Plunger : phít tông của ống bơm.

Sucked & drawn : đút kéo, hút; hấp thụ.

Partially : chỉ 1 phần.

denergized : không bị kích thích

Valves : lưỡi gà

door chimes : chuông ở cửa

sketching : vẽ phác

labeling : ghi tên; nhãn hiệu; đánh dấu.

detail : chi tiết

opposite : đối nghịch

opposite current : cường độ nghịch chiều.

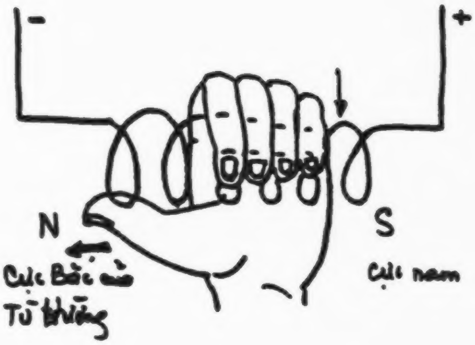
opposite polarities : cực điện đối kháng (cực dương đối với cực âm; Cực Bắc đối cực Nam)

similar : tương tự.

tend : khuynh hướng

LEFT-HAND RULE : (qui tắc) nguyên tắc bàn tay trái. Xác định:

- chiều cường độ
- Cực Bắc
- chiều của từ trường



* Ngón tay cái (bàn tay trái) hướng về cực Bắc của cuộn dây.

* 4 ngón tay chỉ chiều của cường độ điện chạy trong cuộn dây.

horseshoe magnet : nam châm chữ U hình móng ngựa.

stirrup : bàn đạp ngựa (móng ngựa)

petri dish : diã đá

iron fillings : (bột) vụn sắt; mạc sắt.

sprinkle : rắc, vẫy, rải (rải vụn sắt để thí nghiệm)

Symmetrical : cân đối; đối xứng

7-M

磁學 (MAGNETISM)

技術語彙

attract：吸引，相吸

drawing：拉、抽，導引.

pulling：牽引，拖曳，拉、振盪器頻率牽引.

basic law of magnetism：磁學基本定律.

interaction：相互作用.

like poles：同極.

repel：相斥

unlike poles：異極

compass：羅盤，指南針.

earth：大地，地球.

pivot：尖軸、支軸、放在樞軸上的.

direction：方向

ferromagnetic 鐵磁性的，鐵磁的.

cobalt：鈷元素，Co.

classification：分類，分等.

flux lines：磁力线，磁通量.

geographic pole：地理的極.

geographic south pole：地理上南極

keeper 銜鐵，永磁銜鐵

confine：局限，監禁

demagnetizing：去磁，退磁.

magnet：磁鐵，磁体

magnetic field：磁場.

influenced：影響，被作用

affected：受影響.

magnetic force：磁力.

LEI-U.5-2, -8.

magnetic north pole：磁北極，地球有兩地磁極，一為磁北極，另為磁南極，磁北極加拿大北方地理北極的南方1000英哩處，地磁南極在南極大陸地理南極約1500英哩遠處.

magnetic pole：磁極

north seeking pole：指北極 (N-pole).

magnetic shield：磁屏蔽.

prevents：防止，阻擾.

magnetism：磁力，磁學.

magnetite：磁鉄礦

aligned：被排列

natural magnet·天然磁鉄.

natural state：天然狀態.

lodestone = loadstone：天然磁石

exhibits：表现出，展示.

qualities：性質，質.

permananent magnet：永久磁性.

man-made：人為的，人造的.

alnico：磁性合金，由aluminum鋁加nickel鎳加cobalt鈷而

repel：推，拒絕，推卻.

temporary magnet：暫時性磁鉄

special treatment：特別處理.

weak：弱，不強.

electromagnets：电磁

retain：保持，持續

peculiar ability：特別的能力

orient：使方向化，排成向某一方向

definite：固定不變的.

magnetic molecules：磁性分子

domain：範圍，區域.

random pattern：雜乱的排列.

forced：被強迫地

LII-U14-11,
LII-U5-10,

invisible：看不见的.

crossing：交叉,

touching：接觸

dense：集, 密集

concentration：濃密,

common experience：普通经驗.

orientation 方向性, 方向.

hammer：錘, bell hammer：鈴錘鈴舌,

buzzer：鳴峰器.

armature：电極, 衔鉄,

revise motion：反動作.

repeat：重複、反復.

cord：电绳, 塞绳

core：鉄心, 芯(线), 核心

laminate sheets：疊層的

electromagnet：电磁(心).

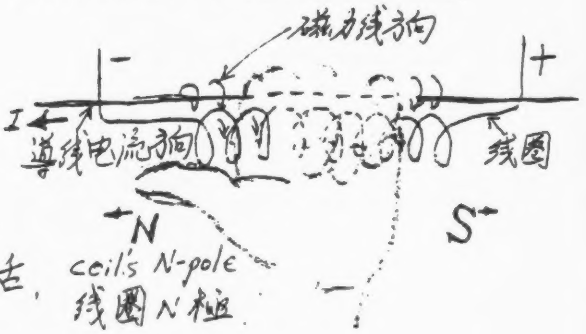
electromagnetism：电磁, 电磁学.

strength：強度.

turns：轉, 圈.

ceases：中止, 终止, 停止.

left-hand rule：左手定則.



lifting magnet：起重电磁鉄

magnetic field：磁场.

magnetic pole：磁極

permeability：磁導率, 滲透性

relay：继电器,

residual magnetism：剩餘磁性

solenoid：螺线管.

cylindrical：圆筒形的.

LII-W4-12, -19, -21, -1

plunger: 撞針, 柱塞.

energized: 被供应能量.

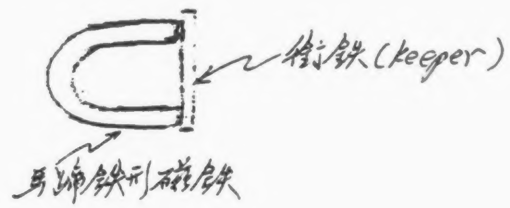
denergized: 被除去能量.

sucking coil: 吸持线圈.

increasing: 增強.

concentrate: 集合, 密集, 濃密.

horseshoe: 馬蹄鉄形的.



stirrup: 馬鐙鉄形.

petri dish: 细菌培養皿.

iron filings: 鉄屑

sprinkle: 撒, 洒.

symmetrical: 相对称性的, 匀称的

stroking: 撫, 摩

tacks: 大頭釘, 扣釘.

inversely: 倒數, 反比例.

configuration: 結構, 形態.

THIS MATERIAL WILL BE INCLUDED LATER

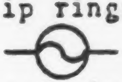
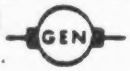
AC/DC ELECTRICITY

Name: ____________

Date: ____________

Period: ____________

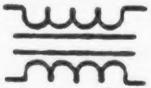
TECHNICAL GLOSSARY

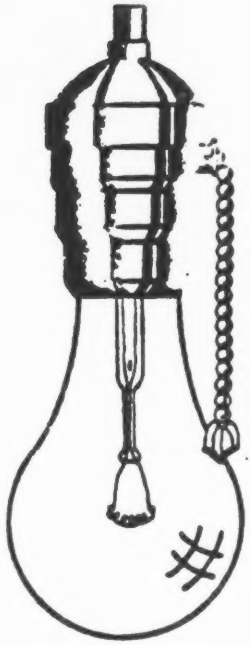
ALTERNATING CURRENT:	A flow of electrons which flow first in one direction, stop, and then flow in the opposite direction. Alternating current can be thought of as a back and forth movement of electrons, varying in amplitude from a maximum to minimum value. The alternating current signal is depicted as a sine wave: ∿ Abbrev. AC.
ALTERNATOR:	An alternating current generator that utilizes a stator, rotor, slip rings, and brushes to produce electricity. Symbol:  Letter symbol: GEN.
AMPLITUDE:	The vertical size or height of an alternating current wave.
CYCLE:	One complete alternating current wave. One cycle consists of two alternations, one positive and one negative.
DIRECT CURRENT:	An electric current which flows in one direction through a circuit from negative to positive. Abbrev. DC.
FREQUENCY:	The number of complete AC waves or cycles which occur during a particular amount of time, usually one second. Measured in the basic unit hertz. Symbol: f.
GENERATOR:	A machine used to produce electricity, either AC or DC, by causing a series of interconnecting coils to either cut or be cut by a magnetic field. Symbol:  GEN Letter symbol: GEN.
POWER FREQUENCY:	The frequency of alternating current electricity used for household energy or power. The power frequency used in the United States is 60 hertz.
POWER LOSS:	The loss of electrical energy due to resistance. Power loss is a major problem in transmission lines, where the combination of current flow and wire resistance will produce heat, causing electrical power to be wasted or lost.
RADIO WAVE:	A high frequency alternating current signal used to carry intelligence or messages through the air. Radio waves for example, are used to carry radio and television signals.
RECTIFICATION:	The process of changing alternating current into direct current.
SIGNAL:	A changing AC voltage or current which contains information. Certain AC signals for example can be changed into sound, light, or magnetic pulses.

Name: ____________________

Date: ____________________

Period: ____________________

SINE WAVE:	The output wave produced by an AC generator. One complete sine wave can be drawn as follows: ∿
SOUND WAVE:	A low frequency AC signal which when applied to a speaker will produce sound that can be heard by the human ear.
TRANSFORMER:	An electronic device, made up of two or more coils of wire which has the ability to either step-up (increase) or step-down (decrease) an AC voltage. Symbol:  Letter symbol: T.
TRANSMISSION LINE:	A wire or heavy cable used to conduct or guide electrical energy from one point to another. Transmission lines generally carry high voltages in the neighborhood of 132,000 volts.



PLEASE!

CONSERVE

OUR

ENERGY

SCORE:

GRADE:

Name: ______________________

Date: ______________________

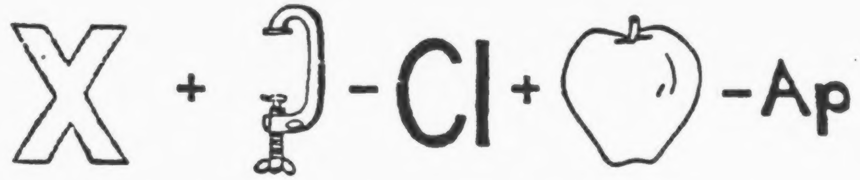
Period: ______________________

WORKSHEET

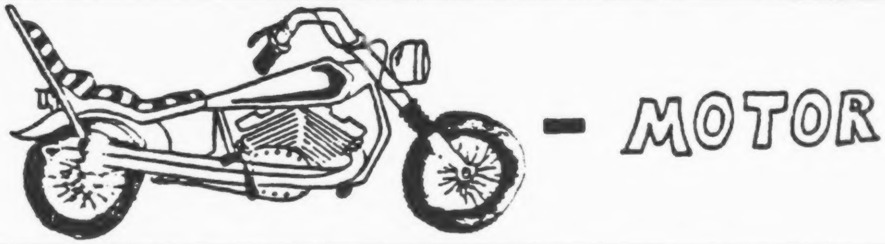
VOCABULARY - GLOSSARY CRYPTICS

Decode the cryptic messages below to identify the electronic term.

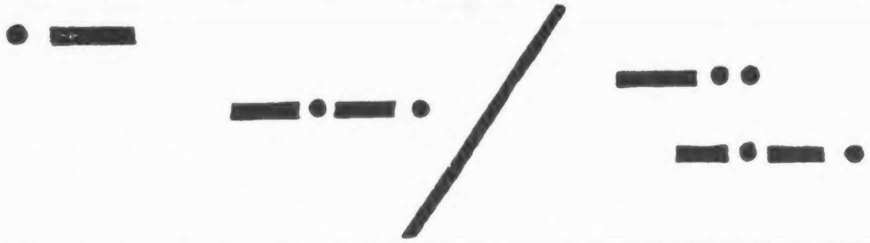
EXAMPLE:

A. 

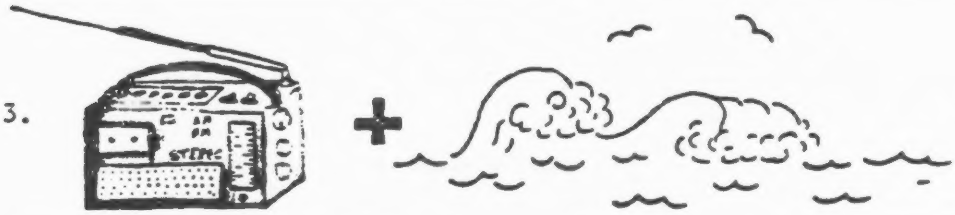
A. EXAMPLE

1. 

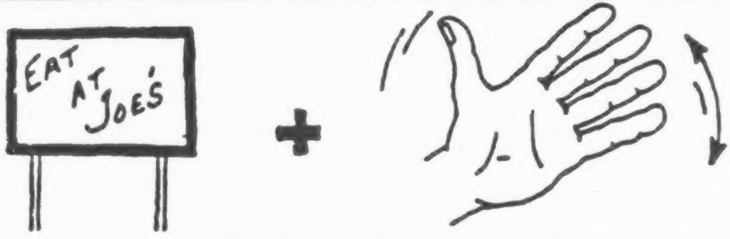
1.

2. 

2.

3. 

3.

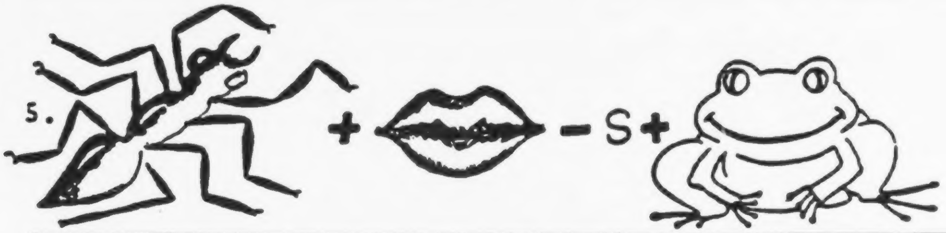
4. 

4.

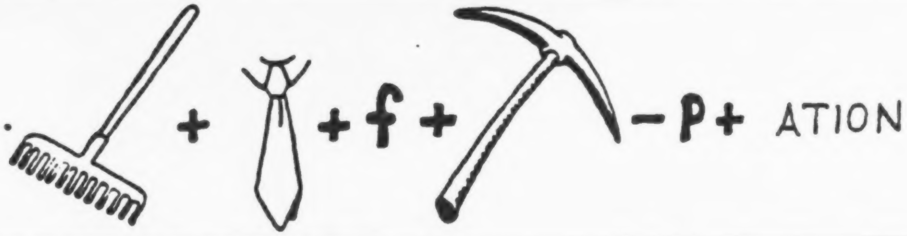
Name: ________________

Date: ________________

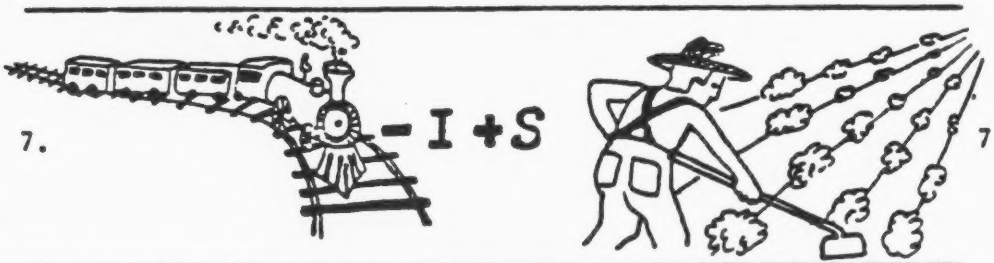
Period: ________________

5.


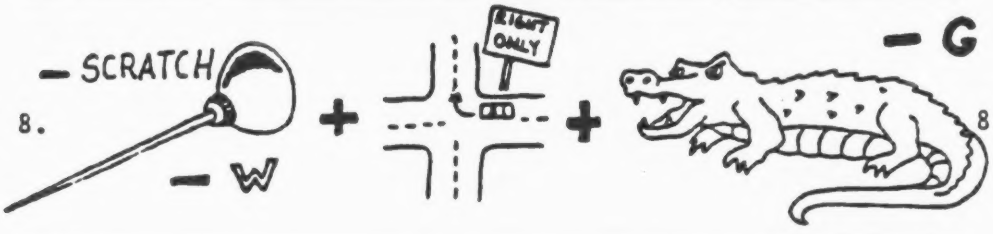
5. ☐

6.


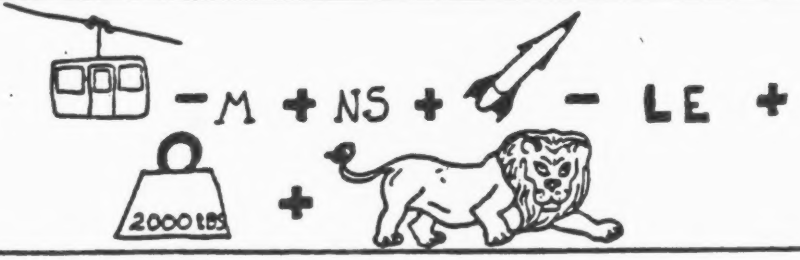
6. ☐

7.


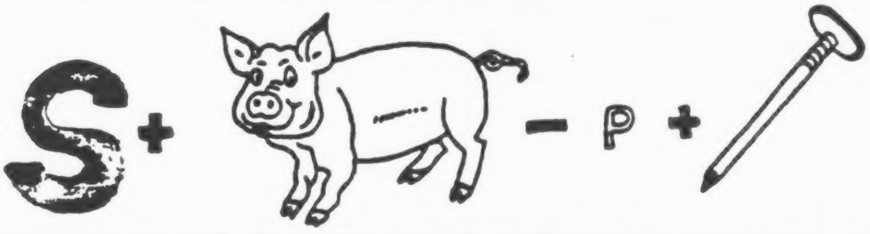
7. ☐

8.

− SCRATCH
− W
+
RIGHT ONLY
+
− G

8. ☐

9.

−M + NS +
− LE +
2000 LBS
+

9. ☐

10.


10. ☐

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

QUEST ACTIVITY

"UNIT 15"

1. Classify the devices listed below according to their primary electrical power requirements. Use the following categories; A) DC operation only, B) AC operation only, or C) combination device, operating on either AC or DC. List the device in the proper column of the chart provided.

DEVICES

flashlight
iron
universal motor
automobile
incandescent lamp
cordless electric razor
electric toy motor
transformer
radio
electric range
washing machine motor
microwave oven

DEVICES

television
door bell
hearing aid
food processor
home movie projector
electric typewriter
electronic flash unit (for cameras)
coffee maker
telephone
portable stereo radio/tape
blow dryer
CB radio - mobile unit

CLASSIFICATION CHART:

	DC Operation Only	AC Operation Only	Combination
A.			
B.			
C.			
D.			
E.			
F.			
G.			
H.			
I.			
J.			
K.			

Name: ____________________

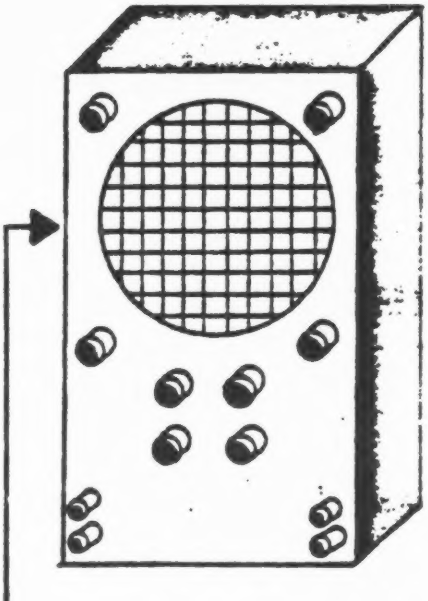
Date: ____________________

Period: ____________________

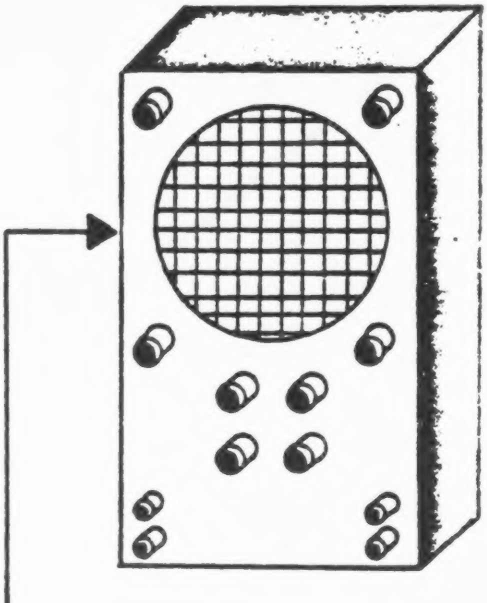
2. Define alternating current:

3. Define direct current:

4. Draw in the appropriate signal or electrical wave on the oscilloscope screens pictured below.



DC WAVE



AC SINE WAVE

Name: ____________________

Date: ____________________

Period: ____________________

5. Describe the four advantages that AC power has over DC power.

A.

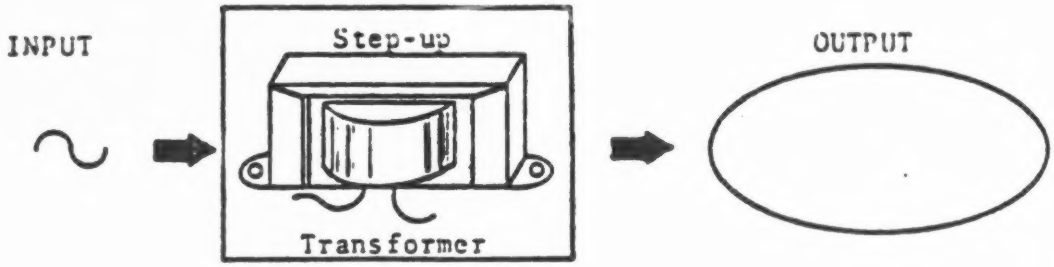
B.

C.

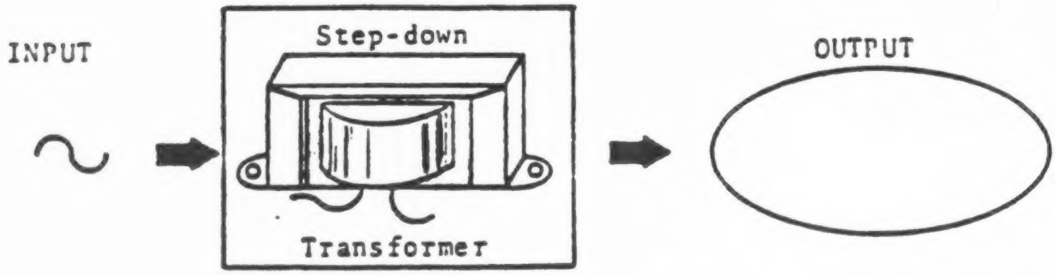
D.

6. Draw the output voltage signal which will be produced by the following devices.

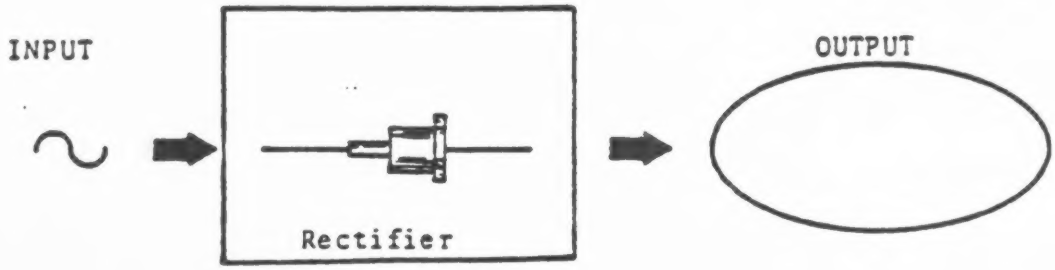
A.


INPUT
Step-up
Transformer
OUTPUT

B.


INPUT
Step-down
Transformer
OUTPUT

C.


INPUT
Rectifier
OUTPUT

Name: ____________

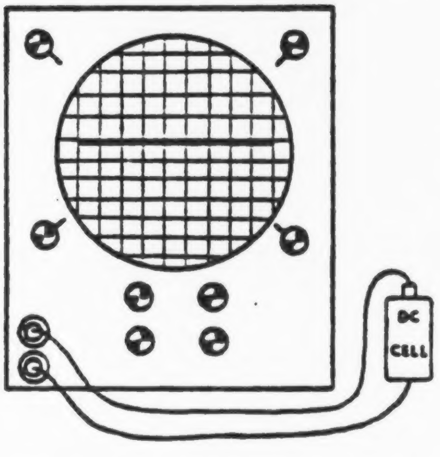
Date: ____________

Period: ____________

INFORMATIONAL HANDOUT

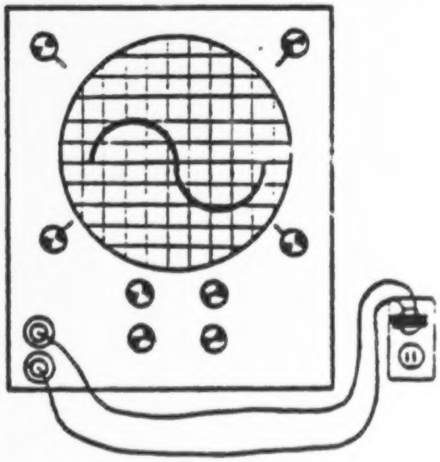
DC AND AC CURRENT CHARACTERISTICS

DC CHARACTERISTICS



- Direct current flows in only one direction through a circuit.
- The polarity of DC current does not change.
- A direct current usually has a steady or constant value.
- Direct current is used exclusively as a source of energy.

AC CHARACTERISTICS



- Alternating current flows in two directions through a circuit, first in one direction, then it reverses, and flows in the opposite direction.
- The polarity of an AC current periodically changes
- An alternating current is continuall changing in value; it will increase from zero to a maximum point in either direction, and then drop back to zero.
- Alternating current can be used as a source of energy, or as an electrical signal - a sound wave, radio wave, or light wave.

DC AC

Name: ____________________

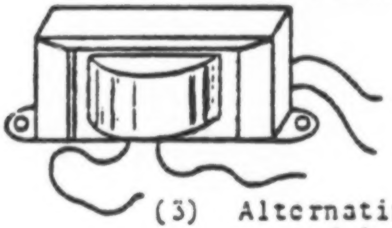
Date: ____________________

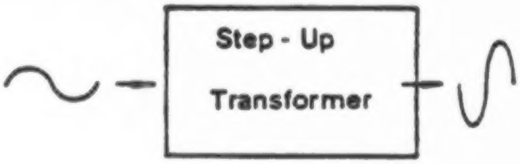
Period: ____________________

ADVANTAGES OF AC VS DC CURRENT

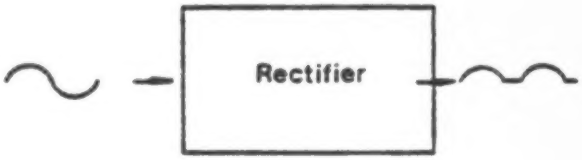
(1) AC generators are less complex than DC generators; they can be constructed in larger sizes, and are more economical to operate. Thus, AC is easier and cheaper to produce.

(2) An AC voltage can be easily stepped-up (increased), or stepped down (decreased), with very little loss of power, by using a transformer.

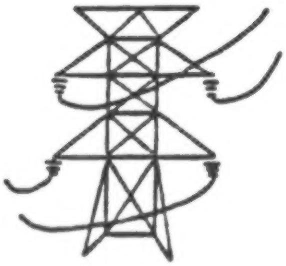


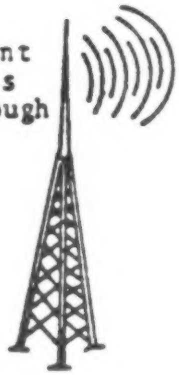


(3) Alternating current is easily converted into direct current, by a diode or rectifier. This converted alternating current, now direct current, can be used to operate various DC circuits.



(4) Because of the ease by which alternating current is transformed to high voltages, it becomes more efficient to transmit on power lines. AC signals can also travel a longer distance through the air than direct current.





AC & DC

ALTERNATING CURRENT	:	điện xoay chiều (AC)
in one direction	:	trong một chiều trực tiếp
opposite direction	:	trực tiếp đối kháng
forth	:	đằng trước
varying	:	sự (đang) đổi khác.
amplitude	:	biên độ (chiều cao của sóng hình sine).
maximum	:	tối đa
minimum	:	tối thiểu.
depicted	:	được miêu tả.
Alternator	:	máy phát điện AC
Alternating current generator	:	máy phát điện AC.
utilize	:	dùng
stator	:	lõi ứng điện cố định.
Rotor	:	phần quay
Slip rings	:	vòng tiếp điện
Brush	:	chổi điện.
vertical	:	trục thẳng (dọc).
cycle	:	chu kỳ
wave	:	sóng

DIRECT CURRENT	:	điện một chiều (DC).
frequency	:	tần số.
occur	:	xảy đến; xảy ra.
during	:	ở trong; trong.
a particular amount of time	:	một số thời gian đặc biệt
hertz	:	đơn vị đo tần số. Viết tắt là: f.
generator	:	máy phát điện.
interconnecting	:	(a) sự nối tiếp nhau.
Power	:	Công suất.
household energy	:	năng lực (dùng trong nhà)
power frequency	:	Công suất tần số; tần số năng lực.
power loss	:	sự mất năng lực. (công suất)
electrical energy	:	năng lực điện.

1. AC

major problem: phần lớn.

transmission lines: dây dẫn truyền.

combination: sự kết hợp.

wire Resistance: điện trở dây.

wasted = lost: tiêu hao; mất đi.

Radio wave: Sóng vô tuyến điện

high frequency: Cao tần số; tần số cao RF

intelligence: tín hiệu tình báo; tín hiệu thuộc mật mã; tín hiệu đặc biệt.

Messages: tin tức

Radio and television signals: Tín hiệu vô tuyến truyền thanh và vô tuyến truyền hình.

signal: tín hiệu

contain: chứa đựng

information: tin tức

Certain: chắc chắn

magnetic pulses: các xung động nam châm.

Sine wave: Sóng hình Sine.

The output wave: sự phát sóng.

AC generator: máy phát điện Xoay chiều.

sound wave: âm ba. làn sóng âm thanh.

Speaker: loa phóng thanh.

the human ear: sự nghe được của con người. (nhân loại).

Transformer: bộ biến thế điện.

ability: năng lực, khả năng.

increase (step-up): tăng lên

decrease (Step-down). giảm xuống

Transmission line: dây dẫn điện loại cáp lớn.

guide: hướng dẫn

Decode: dịch ra

cryptic: Kín; bí mật

identify: nhận rõ

according to: tùy thuộc; tùy theo

2. AC

proper column: cột riêng.

operating on either AC or DC: chạy bằng điện xoay chiều hay một chiều.

Categories (pl) loại, hạng, lớp.

oscilloscope: máy đo dao động

screen: màn ảnh.

advantage: lợi ích.

steady: chắc chắn

constant: bền; vững.

exclusively: độc quyền

periodically change: Thay đổi theo thời kỳ. (Kỳ hạn thay đổi), thay đổi định kỳ.

drop: té xuống, rơi.

light wave: Sóng điện (ánh Sáng).

VS: Source apply Volt. nguồn cung ứng điện.

complex: phức tạp.

easier: tiện lợi, dễ xài (hơn).

cheaper: rẻ hơn.

transformed: biến thế

efficient: tác dụng, hiệu dụng.

longer distance: một khoảng cách dài.

4 TIỆN DỤNG CỦA AC VÀ DC:

1. AC: máy phát điện AC ít phức tạp hơn máy phát điện DC. Chúng có thể xây dựng và chế tạo nhiều kiểu, cỡ. Điện AC Rẻ và dễ sản xuất.
2. Điện AC dễ tăng và giảm Thế do biến thế (Transformer).
3. Điện AC có thể biến đổi thành điện DC do diode.
4. AC có thể chuyển tín hiệu đi xuyên qua một khoảng cách xa hơn điện DC. (tín hiệu chuyển đi qua KKhí).

3. AC

LII-U15-7

直流電及交流电 (DC and AC ELECTRICITY)

技術語彙

alternating current：交流电.

sine：正弦（数学上用語）

wave：波、波狀動態，波浪纹.

amplitude：振幅，幅度．交流电波的縱相度.

cycle：週期．一週期含一正振幅及一負振幅.

frequency：頻率，週波．指在一秒鐘内週期數．以赫茲（Hertz）表示．（週/秒）

power frequency：电力頻率．在美國為60赫茲（60 hertz）.

radio wave：无线电波．如收音机，电視机之信號.

intelligence：通訊，報導.

rectification：整流（將交流电改換為直流电的程序）

signal：信號、符號.

conserve：保存．節省.

transmission line：电力輸送线.

step-up 升压

step-down 降压

input 輸入

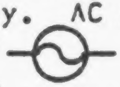
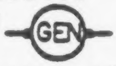
output 輸出.

Name: ____________

Date: ____________

TECHNICAL GLOSSARY

Period: ____________

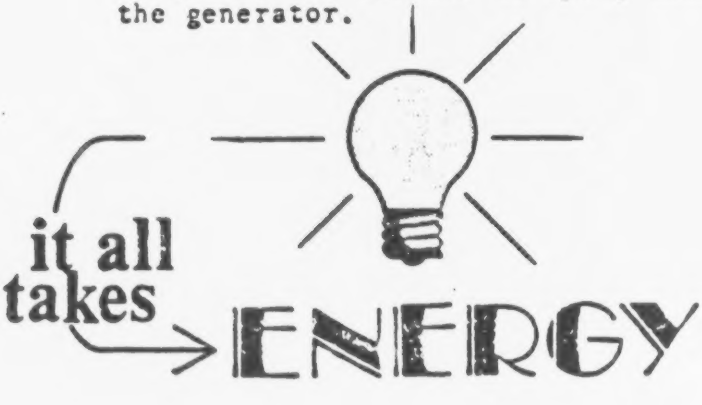
AC GENERATOR:	An electro-mechanical device which utilizes a revolving rotor, a stationary stator, and a slip ring brush set to produce AC electricity. AC generators are also called alternators. Symbol: 
ARMATURE:	The revolving part of a generator or motor. In a generator the voltage is produced within the coils of the armature. In a motor, the armature coils are attracted to and repelled from the field poles, causing motion.
BRUSHES:	A set of small conducting rods, usually carbon or copper which are used to make a sliding contact with the commutator or slip rings.
COMMUTATOR:	A ring of copper segments, insulated from each other, and used as part of the sliding contact between the brushes and the armature of a motor or generator.
DC GENERATOR:	An electro-mechanical device which utilizes a revolving armature, a stationary field magnet or electromagnet, and a commutator - brush set to produce DC electricity. Symbol:  GEN
DISTRIBUTION SYSTEM:	The power system which routes the electrical energy generated at the power plant to the consumer. The system includes; long distance transmission lines, step-down transformers, feeder lines, substation, distribution lines and distribution transformers.
FIELD MAGNET:	Either a permanent magnet or electromagnet used to provide the magnetic field required in a motor or generator.
FOSSIL FUEL:	Fuels such as coal, petroleum, natural gas, and refined petroleum products (gasoline, diesel oil, and fuel oil) which are burned in order to produce heat energy.
GEOTHERMAL:	A natural source of energy produced when water seeps into the ground, is heated by the earth's hot magma core, and then rises to the surface as steam. Geysers, steam vents, and fumaroles are examples of geothermal activity.
HORESEPOWER:	A method of rating the power or "strength" of a motor. One horsepower is equivalent to lifting 550 pounds, one foot, in one second.
HYDRO:	Refers to the energy provided by running or falling water.
MOTOR:	A machine that converts electric energy into mechanical or rotational energy. Motors utilize the magnetic forces of attraction and repulsion to cause an armature to rotate.

Name: ____________________

Date: ____________________

Period: ____________________

NUCLEAR:	A modern source of energy which uses the atomic principles of fission (the breaking of the atom) to produce tremendous amounts of heat. This heat is generally used to convert water into steam.
POWER PLANT:	A large generating facility used to produce the electric energy required by several cities or a section of the state. Power plants may use fossil fuels, hydro, nuclear, geothermal, or other energy sources to supply power to the turbines to turn generators which produce electricity.
ROTOR:	The rotating part of an AC generator or alternator. The rotor supplies a rotating magnetic field within the alternator.
SLIP RINGS:	Two copper rings which, along with the brushes, provide a sliding contact with the rotor of an alternator, or generator.
STATOR:	The stationary coils of an AC generator, in which voltage is produced.
SUBSTATION:	Part of an AC power distribution system where the high voltage energy from the transmission lines is changed to a usable voltage - current value. The substation includes transformers, switches, circuit breakers, and other equipment.
TRANSMISSION LINE:	The high tension power lines which are usually strung between steel towers, and carry the high voltage - low current AC energy from the power plant to the substation.
TURBINE:	A finned device, similar to the blades of a fan, which is connected to the rotor of the power plant generator. When steam or water is forced into the turbine blades, it causes the turbine to spin, thus turning the rotor of the generator.



SCORE:

GRADE:

Name: ____________

Date: ____________

Period: ____________

WORKSHEET

VOCABULARY WORD DECODING

The words below have little meaning until they are decoded. Each letter actually represents another letter in the alphabet. Your task is to break the code and decode each word. The example will get you started by providing four decoded letters. The code remains the same throughout the worksheet.

EXAMPLE:

A. D Y G Y V H S T A T O R	A. STATOR
1. C V Y V H – – – – –	1.
2. G H C G Y K H R – – – – – – – –	2.
3. Y K H M O N R – – – – – – –	3.
4. A V C C K Y G Y V H – – – – – – – – – –	4.
5. W R N R H G Y V H – – – – – – – – –	5.
6. K R V Y B R H C G I – – – – – – – – – –	6.
7. D K M D Y C Y O V N – – – – – – – – – –	7.
8. X O R I L C G W N R Y – – – – – – – – – – –	8.
9. M H K D B R D – – – – – – –	9.
10. Y H G N D C O D D O V N I O N R – – – – – – – – – – – – – – – –	10.

SCORE:

GRADE:

Name: ____________

Date: ____________

Period: ____________

WORKSHEET

DC MOTORS AND ELECTRIC GENERATORS

1. A device which has the ability to change electrical energy into mechanical or rotational energy is called a __________. 1.

2. A motor contains at least __________ interacting magnetic fields. 2.

3. The armature in a motor rotates as a result of __________ attraction and repulsion. 3.

4. List the four basic parts of a DC motor.

4A.

4B.

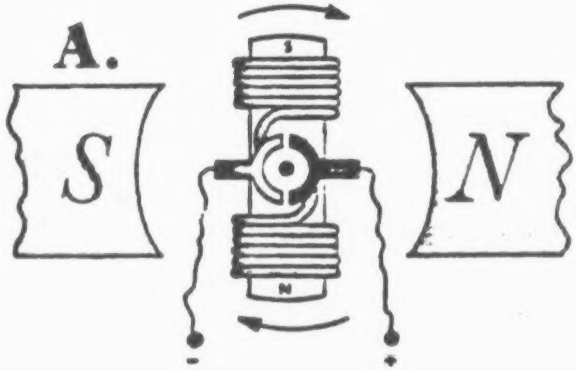
4C.

4D.

5. The __________ and __________ form a rotating switch which controls the direction of current flow through the armature of a DC motor. 5A. 5B.

6. Explain what occurs when the current flow through the armature reverse in direction.

7. Briefly describe the "motor action" occuring in the drawings below - pay particular attention to the location and effect of the commutator.

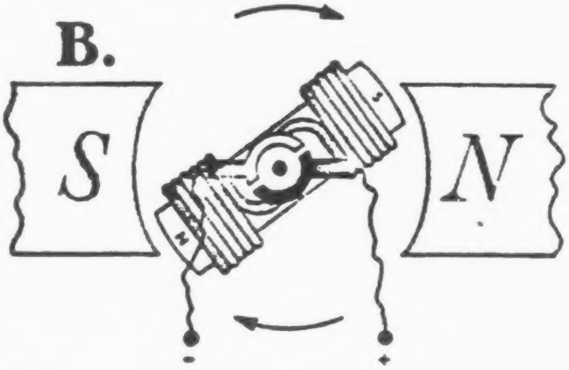


Name: ____________________

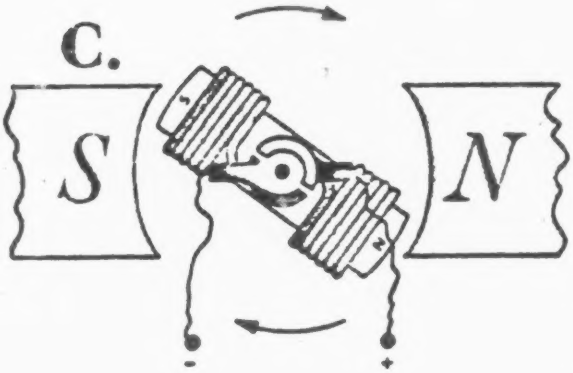
Date: ____________________

Period: ____________________

B.



C.



8. List four common causes of motor failure.

8A. ☐

8B. ☐

8C. ☐

8D. ☐

9. Explain why friction is so damaging to an electric motor and suggest a way friction can be reduced to an acceptable level.

10. What is the main physical difference between a simple AC and DC generator?

Name: ____________

Date: ____________

Period: ____________

11. List the three basic requirements necessary to generate a voltage.

11A. ☐

11B. ☐

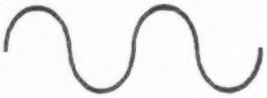
11C. ☐

12. Identify the generator output waves pictured below.

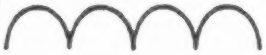
12A. ☐

12B. ☐

A.



B.



13. The __________ in the DC generator acts as a rotating switch, allowing the output current to flow in only one direction.

13. ☐

14. The A)__________ in an alternator will provide a strong electromagnetic field, which when rotated or turned, will generate a voltage in the stationary B)__________ windings.

14A. ☐

14B. ☐

15. Name three factors which will affect the output of a generator. In each case indicate how the output will be affected.

A. ☐

B. ☐

C. ☐

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

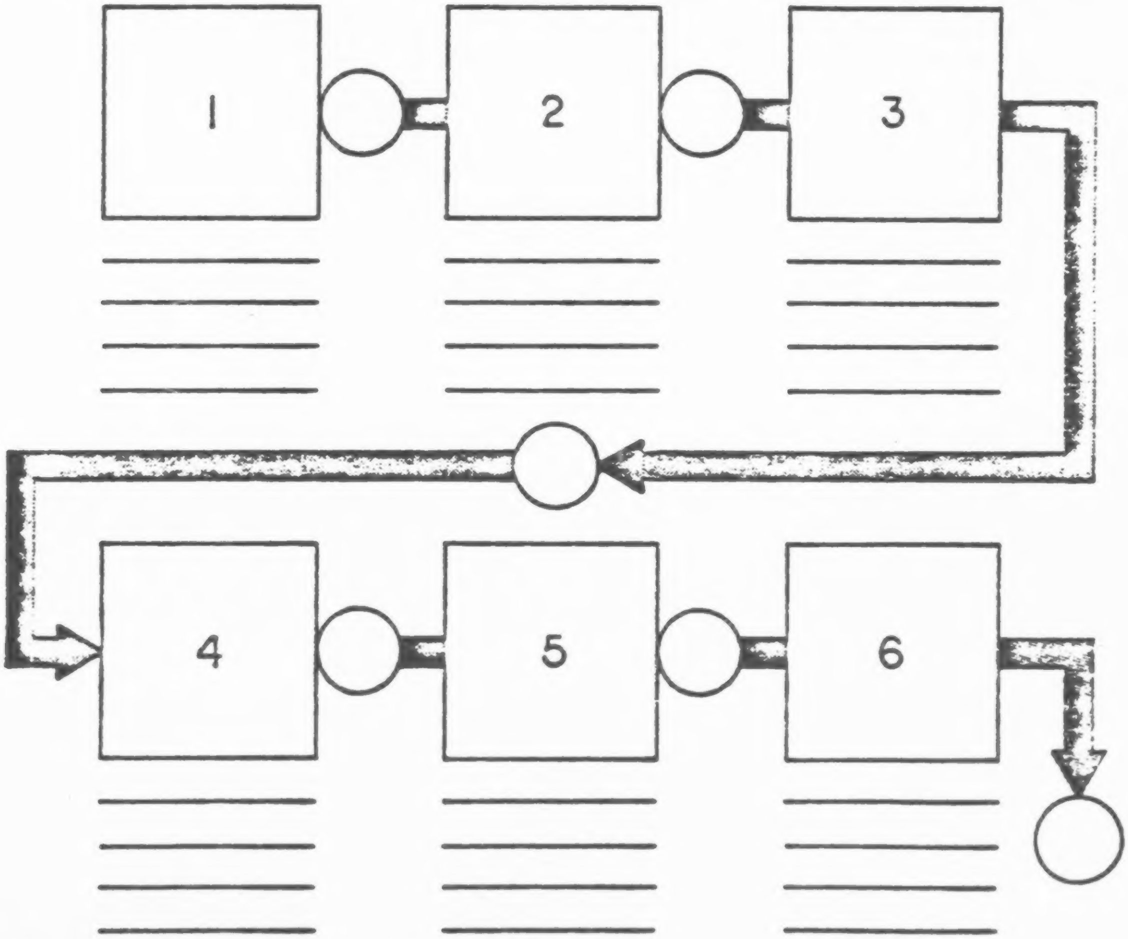
WORKSHEET

QUEST ACTIVITY

"UNIT 16"

Utilizing the appropriate "puppets" on the attached page, cut out and place each "puppet" element in proper sequence to form a complete AC Power Distribution System. In the circles to the right of each "puppet", insert the approximate voltage. Begin with the production point and conclude with the energy user. Remember, below each "puppet" write a brief description of what is happening at that specific location.

1.



2. **AC power systems** are needed to: (in detail) ____________________

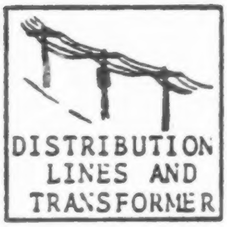
____

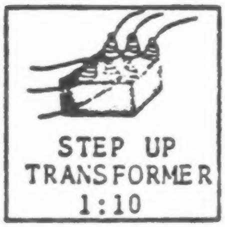
____

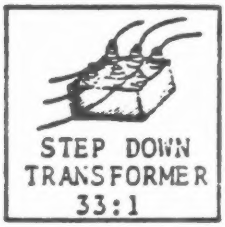
____

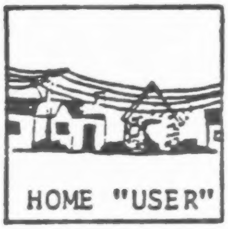
____

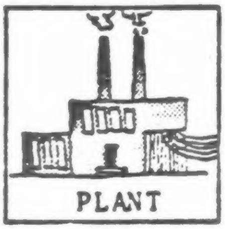
Puppets

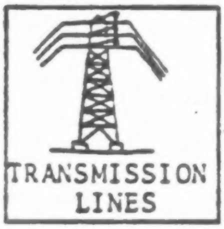

DISTRIBUTION LINES AND TRANSFORMER


STEP UP TRANSFORMER 1:10


STEP DOWN TRANSFORMER 33:1


HOME "USER"


PLANT


TRANSMISSION LINES

4,000 V

132,000 V

STOP

132,000 V

120/240 V

13,200 V

NOTE: Cut carefully around each puppet, use glue or tape to secure puppet to paper and be as neat as possible.

Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

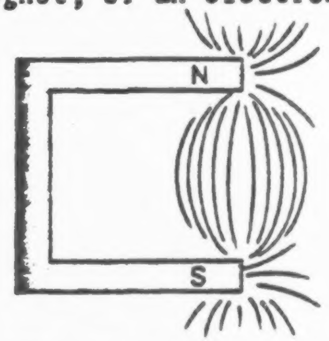
OPERATION OF A SIMPLE DC MOTOR

An electric motor is able to convert electrical energy into mechanical or rotational energy. The first crude electric motor was developed in 1831 by an American, Joseph Henry. Today electric motors are used in hundreds of home appliances and thousands of pieces of industrial equipment.

Basically, electric motors operate on the principle of magnetic repulsion and attraction - that is, like poles repel, and unlike poles attract. In its simplest form, a DC motor will contain two interacting magnetic fields, one stationary, and one which is able to rotate or revolve. These two interacting fields cause the motor to produce "torque", or rotational energy.

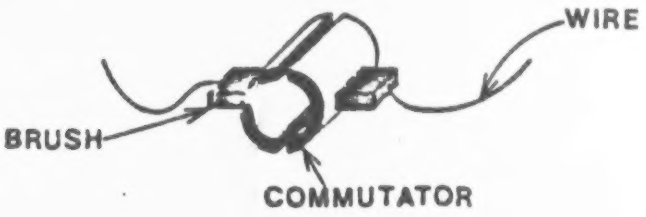
The basic parts of a DC motor are the:

● Field magnet; a stationary magnetic field provided by either a permanent magnet, or an electromagnet.



▲ Armature; an electromagnet wound on a shaft or axle. The armature will revolve within the field magnet.

⬢ Commutator and Brushes; the commutator is made up of at least two segments of copper, which are insulated from each other, and are located on the armature shaft. Connected to each commutator segment is one end of the wire which makes up the armature coil. The brushes which are made of either carbon or copper, ride against the commutator, forming a rotating connection.

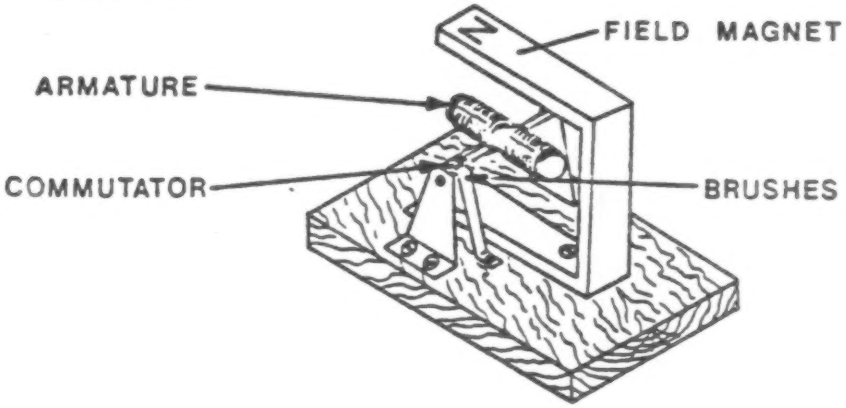


Name: ____________________

Date: ____________________

Period: ____________________

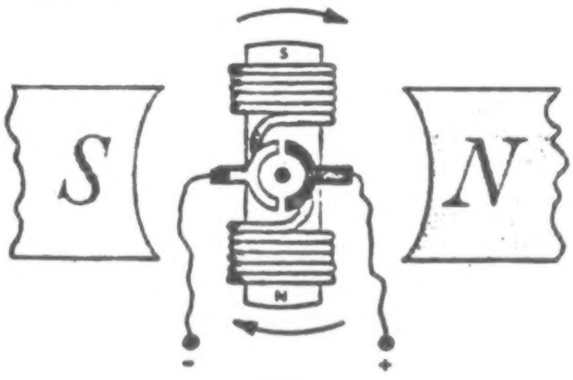
A SIMPLE DC MOTOR



HOW THE DC MOTOR WORKS

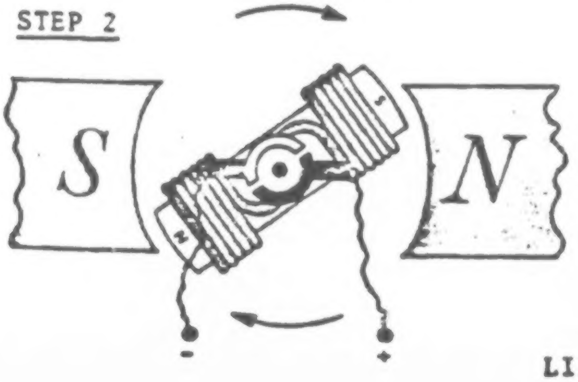
The key to the operation of a DC motor is the armature/commutator action. Recall, the armature is basically a coil of wire, which forms an electromagnet when current flows through it. The direction of current flow through the coil will determine the north and south poles of the electromagnet. The commutator and brushes, in turn, will route the current through the armature coils in the proper direction to cause the armature to be attracted to or repelled from the proper field pole at the proper time.

STEP 1



When a battery is connected to the brushes and commutator as shown, the armature coil produces a magnetic field having a south pole at the top of the coil, and a north pole at the bottom. In this case, the armature poles will be attracted toward the field magnet poles in a clockwise direction.

STEP 2



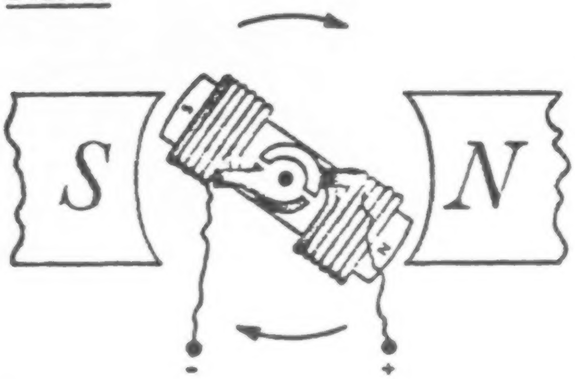
As the armature approaches the horizontal position its magnetic polarity must be changed in order to prevent the armature from being trapped by the strong field magnet's north pole and stopping. If you look closely at the commutator, you will notice that the brushes are approaching the gap between the commutator segments. Once the brushes contact the gap, the armature field is momentarily turned off, allowing it to rotate past the field poles.

Name: ______________________

Date: ______________________

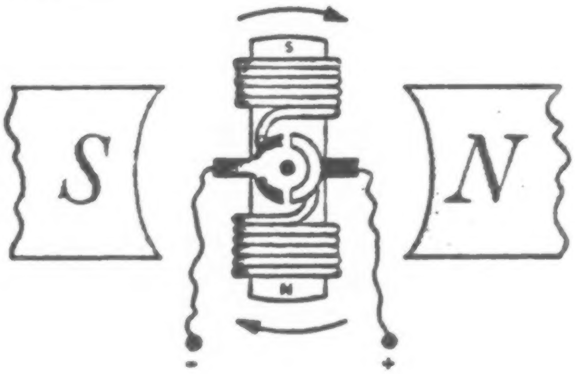
Period: ______________________

STEP 3



When the brushes touch the next commutator segment, (the positive brush is now contacting the segment formerly touched by the negative brush). The polarity of the armature is reversed. The poles of the armature are now repelled by the field magnet.

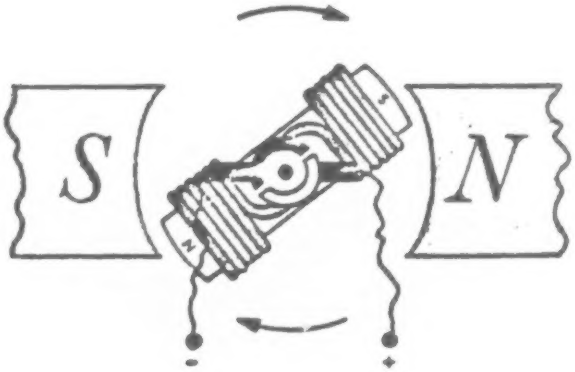
STEP 4



As the armature continues to rotate the armature's electromagnet and the field magnet begin to attract each other, and rotation continues.

See if you can complete the descriptions for steps 5 and 6 of the motors operation.

STEP 5

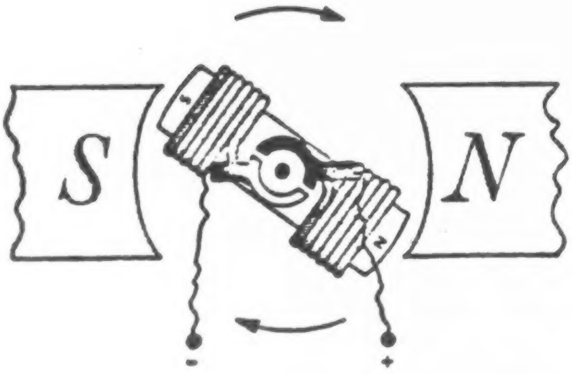


Name: ____________________

Date: ____________________

Period: __________________

STEP 6



Finally, the armature will return to its starting position as shown in step 1, completing one revolution.

ANSWERS:

Step 5.

Similar to description in Step 2.

Step 6. Similar to description in Step 3.

Name: ______________________

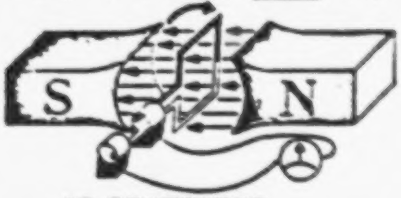
Date: ______________________

Period: ______________________

INFORMATIONAL HANDOUT

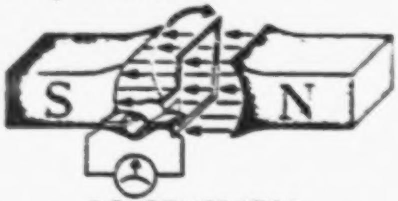
THE BASICS OF DC AND AC GENERATORS

Generators convert mechanical energy into electrical energy by a process known as electromagnetic induction; that is by either moving a coil of wire through a magnetic field, or by holding the coil stationary, and moving the magnetic field. DC generators produce pulses of electricity which always have the same polarity - either positive or negative; while AC generators produce pulses of electricity which periodically change "polarity", having both a positive and negative portion.



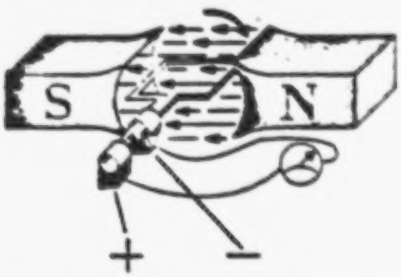
AC GENERATOR

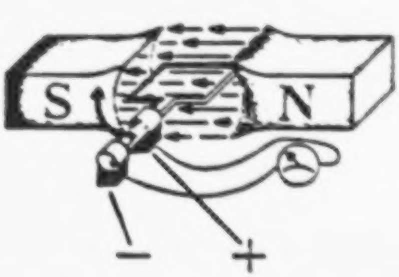
NOTE: Meter center is zero.



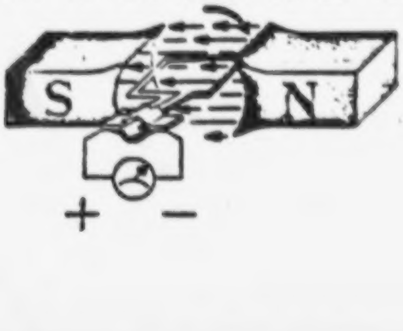
DC GENERATOR

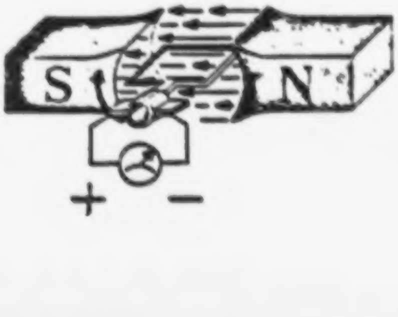
The difference between the two generators lies in the direction that the generated current is allowed to flow through the coil. In an AC generator (alternator), the ends of the coil loop are connected to a set of slip rings which permits current to flow first in one direction, (as the loop moves past the north field pole) and then to reverse, and flow in the opposite direction, (as the loop moves past the south field pole). Thus, the potential of the voltage present on the brushes changes first from + to - then from - to +.





The DC generator uses a commutator, instead of slip rings, as the end connection of the armature loop. The commutator causes the current to flow in only one direction from the coil. The half of the loop passing the north field pole will always produce one potential (negative), while the half of the loop which passes the south field pole will always produce the opposite potential (positive). Thus, the potential of the voltage present on the brushes is always the same - one positive, and one negative.





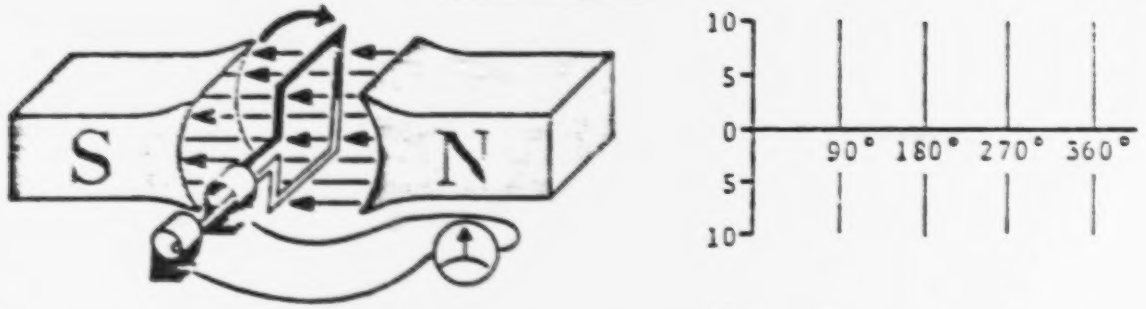
Name: ____________________

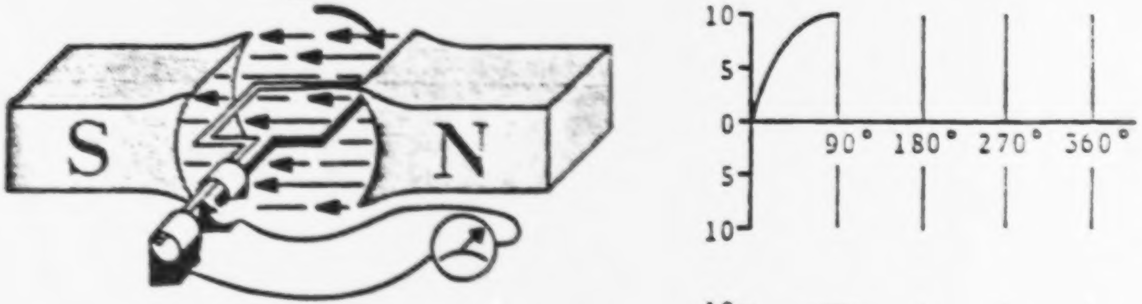
Date: ____________________

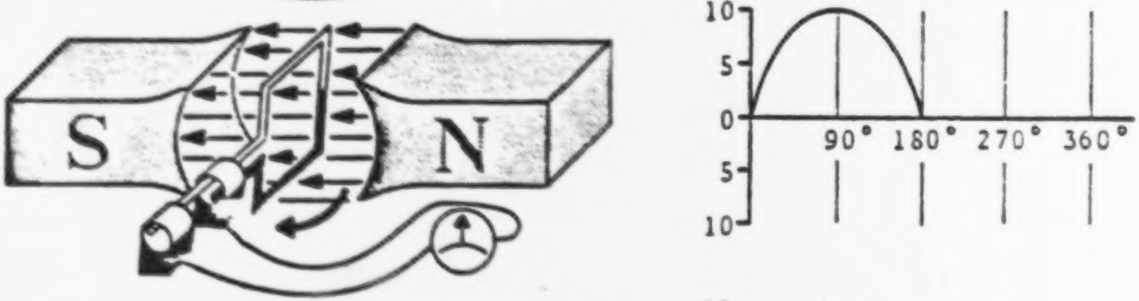
Period: ____________________

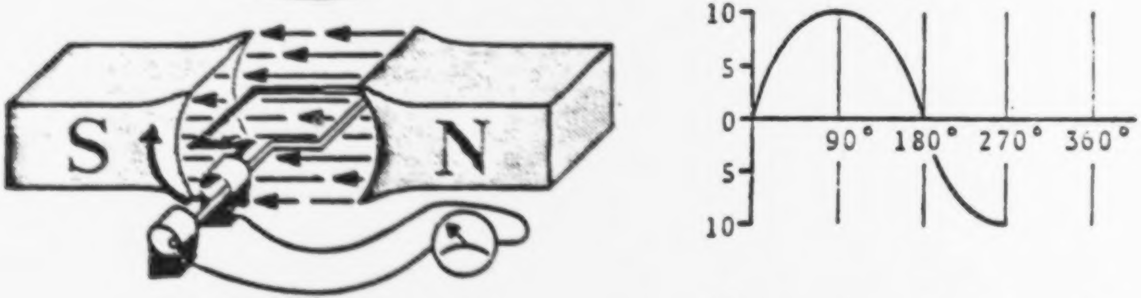
AC AND DC GENERATION:

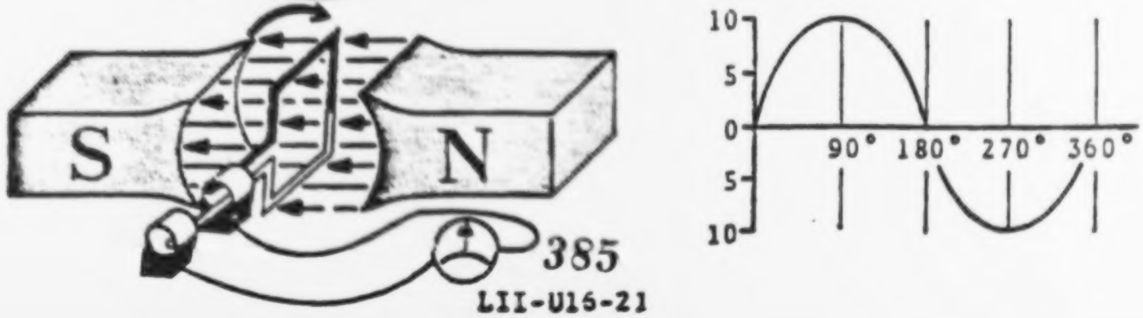
AC GENERATOR


S
N
10
5
0
5
10
90°
180°
270°
360°


S
N
10
5
0
5
10
90°
180°
270°
360°


S
N
10
5
0
5
10
90°
180°
270°
360°


S
N
10
5
0
5
10
90°
180°
270°
360°

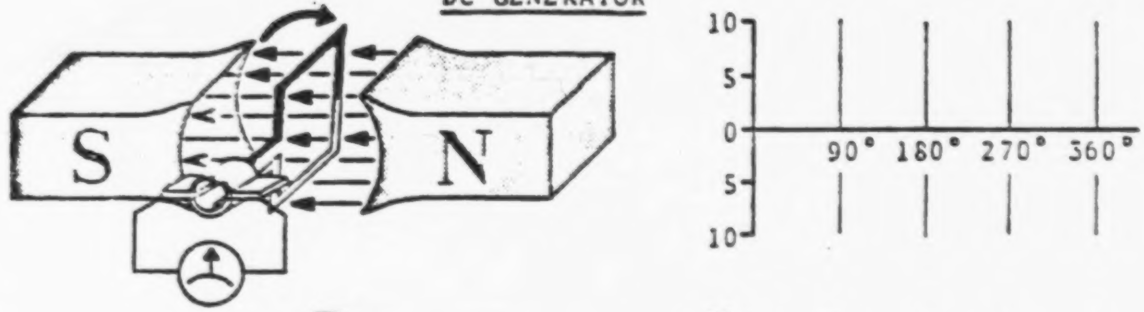

S
N
10
5
0
5
10
90°
180°
270°
360°

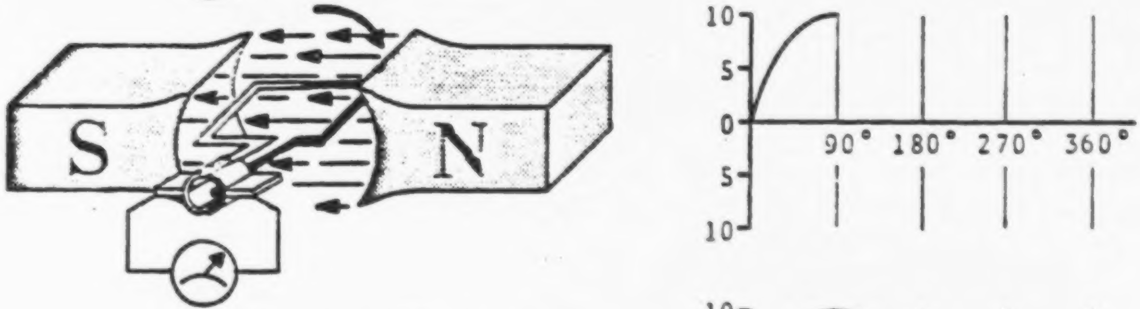
Name: ______________________

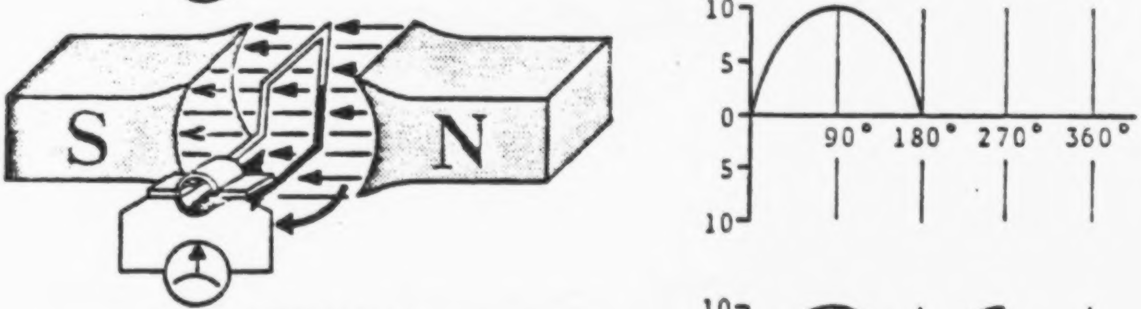
Date: ______________________

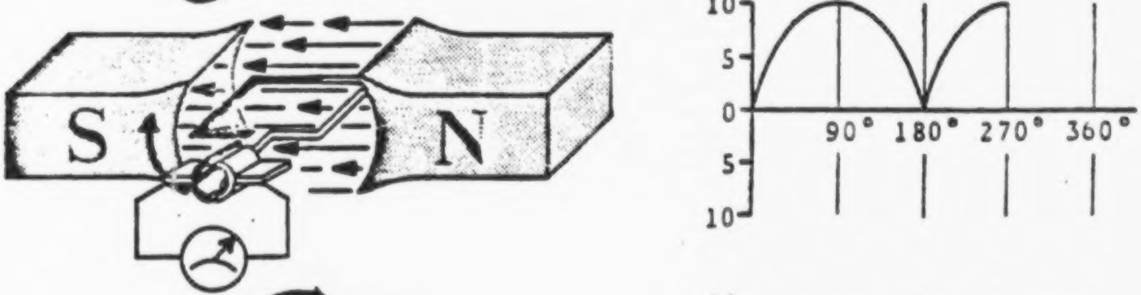
Period: ______________________

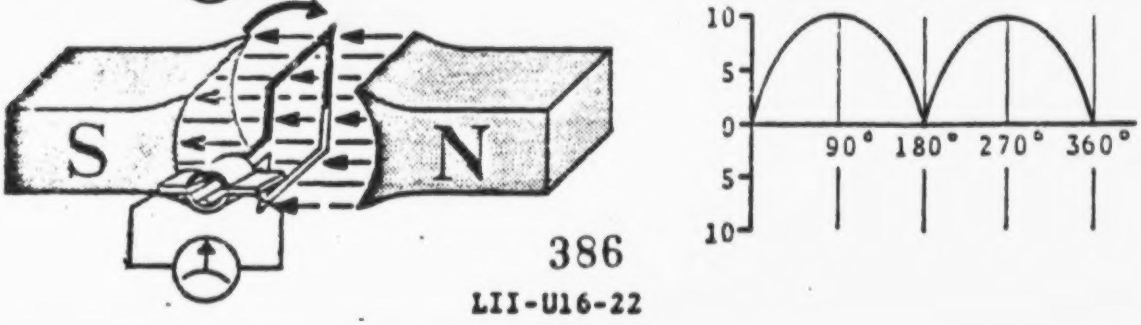
DC GENERATOR


S
N
10
5
0
5
10
90°
180°
270°
360°


S
N
10
5
0
5
10
90°
180°
270°
360°

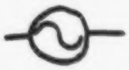

S
N
10
5
0
5
10
90°
180°
270°
360°


S
N
10
5
0
5
10
90°
180°
270°
360°


S
N
10
5
0
5
10
90°
180°
270°
360°

MOTORS & GENERATORS

AC generator : máy phát điện AC cũng gọi Alternator.

Ký hiệu : 

revolving rotor : phần quay

stationary : đứng yên ; cố định ; không đổi.

stationary stator : phần ứng điện cố định

slip ring : vòng tiếp điện

Brush : chổi điện.

ARMATURE : phần ứng điện

- phần quay trong máy phát điện hay môtơ.

coil : cuộn dây

attract : hút

Repel : đẩy.

field pole : cực của từ trường

motion : sự chuyển động ; động lực.

rod : que

carbon : than

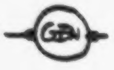
copper : đồng

sliding : trượt (slide)

contact with : liên lạc với

commutator : - núm chỉnh lưu
- vòng góp điện bằng đồng.

DC generator : máy phát điện DC

Ký hiệu : 

revolving armature : phần quay trong máy phát điện DC.

stationary field megnet : vùng nam châm cố định.

electromagnet : nam châm điện.

distribution system : hệ thống phân phối điện.

power system : hệ thống năng lực. hệ thống công suất.

generate : sản xuất, sinh ra.

power plant : trạm phát điện.

consumer : người tiêu thụ

long distance transmission lines : đường dây chuyển vận khoảng xa.

step-down transformer : bộ phận hạ thế điện.

Feeder lines	đường dây điện. (dây dẫn từ bộ hạ thế đến trạm biến thế phụ)
substation	trạm biến thế phụ.
distribution lines	đường dây phân phối điện.
distribution transformer	biến thế phân phối (đến nơi tiêu thụ)
field magnet	vùng nam châm
permanent magnet	nam châm vĩnh cửu.
electromagnet	nam châm điện.
Fossil	hoá thạch
Fossil Fuel	nhiên liệu hoá thạch.
Coal	than
Petroleum	dầu hoả
natural gas	ga thiên nhiên.
refined	lọc
refined Petroleum	dầu lọc
gasoline	xăng
diesel oil	dầu cặn
fuel oil	nhớt

in order to	để
heat energy	nhiệt năng (năng lực bằng hơi nóng; sức nóng).
Geothermal	địa nóng
natural source of energy	nguồn năng lượng thiên nhiên.
seep (vt)	ngấm dần, thấm vào.
The earth's hot magma core	hoả quyển (sức nóng của lòng đất)
rise to	bốc lên; bốc hơi
surface	bề mặt
steam	hơi nước
Geysers	suối nước nóng
steam vents	mạch hơi nước
fumaroles	phún xuất thạch (nham thạch từ lòng đất phun lên).
geothermal activity	sự hoạt động địa năng.
Horsepower	mã lực bằng 550 cân anh

2 M ẹ G

rating : số lượng .
strength : sức mạnh .
Hydro : chỉ về năng lực được tạo ra do nước chảy hoặc nước đổ xuống .
Refer to : chỉ về
motor : mô-tơ (động cơ quay chạy bằng điện từ)
electric energy: năng lực điện cơ
rotational energy : năng lực quay
magnetic force : sức mạnh của từ lực .
nuclear : nguyên tử (hạch nhân); hạch tâm.
atom principle , nguồn nguyên tử
fission : sự phân thể; phá vỡ
the breaking of the atom : sự phá huỷ nguyên tử
tremendous : ghê gớm; rùng rợn .
tremendous amounts of heat : số lượng sức nóng ghê gớm; (số lượng nóng tột độ).
facility : sự tiện ích .
turbine : bộ phận quay để chạy máy (cánh quạt chạy bằng nước . .)
to spin : quay
task : phần việc; bài làm
acceptable level : mức có thể chấp nhận được .
suggest : phát biểu ý kiến
friction : sự cọ, đụng chạm .
factor : yếu tố; nguyên động lực .
insert : cho vào; đẩy vào .
brief : vắn tắt, tóm tắt
crude : chưa hoàn thiện (thô sơ)
interacting : tác dụng hỗ tương.
approaches : đạt tới
trapped : bị kẹt
gap : khe hở
Momentarily: tạm thời
reverse : ngược lại; đảo lại.

3_ M & G

发电機 (GENERATOR)

技術語彙

generator：发电机，一种电机装備.

utilizes：利用

revolving：旋轉的

rotor：迴轉軸，轉子.

stationary：固定的.

stator：固定子，固定片.

slip：滑動的.

ring brush：環形(电)刷

alternator：交流发电机，即AC generator.

armature：电極，衔鉄.

attracted to：吸引，相吸

repelled from：推卻，相拆

field ples：場磁極，磁場线圈架.

brushes：电刷

commutator：換向器，整流器.

segment：部份，扇形齒輪，分節.

field magnet：場磁鉄.

electromagnet：电磁鉄.

distribution system：配电系统

power system：电力系统

route：路线，定路线，(由某路线)遞送

power plant：发电廠

consumer：使用户.

transmission line 輸电线.

step-down 降压，降低电压.

transformer：变压器，变換器.

feeder line：饋(电线)路，饋路

substation：分局，分台，变电所.

L22-U16-8,-9

permanent：永久性的.

fossil fuel：地下埋藏的燃料

coal：煤

petroleum：石油

natural gas：天然気

refined：精煉的，提煉的

products：成品

gasoline：汽油

diesel oil：柴油

fuel oil：燃料油

geothermal：地热的.

seep：滲流.

magma core：岩漿地心.

steam：蒸氣，温泉.

geyser：噴泉

vents：孔，口.

fumarole：噴気孔(火山的).

horsepower：馬力

hydro：水力的.

nuclear：核能.

fission：[核]裂變．分裂.

facility：設備.

turbines：渦輪.

slip ring：滑动環

circuit breaker：断路器，断路[illegible]
阀.

tension：張力，拉力，电压

strung：(string之过去式)串列.

finned device：精良的裝備

spin：旋轉

interacting：相互作用.

torque：轉(力)矩

LII-U16-16

shaft：柱，桿，軸

axle：軸

crude：粗造.

poles：極.

polarity：極性.

trapped：被捕捉，被誘入.

gap：裂口，间隙，

momentarily：暫時地，時時刻刻地

reversed：被改換成相反的.

pulses：脈搏，脈衝，瞬间波动.

loop：回线，循環，匝，環，

THIS MATERIAL WILL BE INCLUDED LATER

Name: ____________________

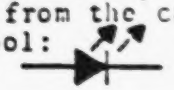
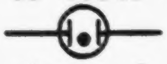
Date: ____________________

Period: ____________________

INSTRUMENTATION
TECHNICAL GLOSSARY

AUDIO GENERATOR:	A piece of test equipment designed to produce a continuous output signal - sine or square wave - which has a selectable output frequency generally between 20Hz to 200kHz.
BRIGHTNESS CONTROL:	Oscilloscope control used to control the brightness or intensity of the trace on the screen.
CAPACITOR CHECKER:	Test instrument designed to check capacitors for shorts, opens, leaks, and farad value.
CATHODE RAY TUBE:	The visual display tube on the oscilloscope. A sweeping electron beam illuminates fluorescent atoms, coated on the inner face of the tube, to produce visible light. Abbrev. CRT
DIGITAL MULTIMETER:	A multimeter whose input or measured value is displayed directly as illuminated digits or numbers. Abbrev. DMM
FINE FREQUENCY ADJUSTMENT:	An oscilloscope control which is used as a fine adjustment for the horizontal sweep oscillator. This control will stabilize or "lock in" a slowly drifting signal.
FOCUS:	An oscilloscope control used to adjust the trace into a sharp, clear image.
FREQUENCY COUNTER:	A piece of test gear designed to accurately count or measure AC frequencies. Modern frequency counters have a digital display.
FREQUENCY RANGE CONTROL:	A signal generator control used in conjunction with the main tuning dial as a frequency multiplier. Typical range control markings would be X1, X10, X100, etc.
FUNCTION GENERATOR:	A type of signal generator capable of providing sine, square, triangle, ramp, and pulse output waves.
GRATICULE:	The major markings on the oscilloscope screen. The graticules are used when measuring a voltage or frequency.
GRID DIP METER:	An instrument used primarily to tune transmitters or oscillators to a designated frequency.

Name: ____________________

HORIZONTAL GAIN:	An oscilloscope control which increases the length (left to right) of a scope trace. Many scopes uti two controls, one to adjust gain in large steps, and a variable resistor to provide fine adjustment.
HORIZONTAL INPUT:	An oscilloscope input which is used to apply an external signal to the horizontal deflection plates of the CRT.
HORIZONTAL POSITIONING:	An oscilloscope control which will move the trace across the screen in a horizontal direction.
IMPEDANCE BRIDGE:	An instrument used to accurately measure or determine resistance, capacitance, or inductance values, using a ratio-comparitive process.
LIGHT EMITTING DIODE:	A two element semiconductor device which produces visible light when current flows from the cathode to the anode terminal. Graphic symbol:  Abbrev. LED
MAIN TUNING DIAL:	A signal generator control used to "adjust for" or "tune in" a specific frequency.
NEON LAMP INDICATOR:	A voltage sensitive glow lamp which requires approximately 55 volts to ionize and produce light. Graphic symbol:  Letter symbol: LP
OSCILLOSCOPE:	A basic piece of test equipment used to display voltage waveshapes on the screen of a cathode ray tube. The oscilloscope can also be used to measure AC or DC voltages and AC frequencies.
OUTPUT LEVEL CONTROL:	A signal generator control used to adjust the output voltage or amplitude of the generated output wave.
PROBES:	Special test lead designed to be used only with particular pieces of test equipment. Typical examples RF probes, high voltage probes, etc.
RADIO FREQUENCY GENERATOR:	A piece of test equipment which is designed to produce a continuous sinusoidal output signal that is adjustable over a range of approximately 150KHz to 150MHz. Most instruments also include a fixed audio frequency which can be mixed (modulated) with an RF signal.
RF POWER METER:	A test instrument used to measure output power of a transmitter. One type of RF power meter will connect in series between the transmitter and a dummy load. Also referred to as an RF wattmeter.
SIGNAL TRACER:	A test instrument that is useful in troubleshooting radio and audio circuits. It basically consists of a widerange amplifier and detector circuit.

Name: ______________

SWEEP FREQUENCY:	An oscilloscope control used to select the frequency band over which the internal oscillator operates. The higher the sweep frequency, the faster the electron beam moves across the face of the scope.
SWEEP GENERATOR:	A piece of test equipment utilized mainly in tuning or aligning FM radios and television receivers. The instrument produces a sinusoidal signal that continually varies in frequency, above and below a tuned center frequency.
SYNC AMPLITUDE:	An oscilloscope control used to adjust the triggering or sync circuit within the scope. It will assist in locking the input signal and the horizontal sweep in order to obtain a stationary pattern.
SYNC SELECTOR:	An oscilloscope control or switch used to select the method of signal synchronization - internal, external or 60Hz sync mode.
TRANSISTOR-DIODE TESTER:	A test instrument designed to check semiconductor diodes and transistors. Test modes may include; leakage test, gain test, and short or open test.
TRANSISTORIZED VOLTMETER:	A basic measuring instrument which utilizes a transistorized circuit to drive a meter movement. Abbrev. TVM
TRIGGERED SWEEP:	An oscilloscope circuit which allows you to view a signal as a stationary pattern.
TUBE TESTER:	A test instrument designed to check vacuum tubes. Most tube testers will evaluate filament continuity, shorts, and the ability to amplify a signal.
VACUUM TUBE VOLTMETER:	A test instrument able to measure voltage and resistance, with the meter circuit designed around vacuum tubes. The instrument is usually not portable, requiring a source of 117V AC. Abbrev. VTVM
VERTICAL GAIN:	An oscilloscope control which will adjust the instruments sensitivity to a vertical input. It has a similar function to the range switch on a voltmeter. Many scopes utilize two controls for this purpose, one to adjust gain in large steps, and a variable resistor to provide fine adjustment.
VERTICAL INPUT:	The most commonly used oscilloscope input terminals and this input will allow the beam to deflect in the vertical direction when a voltage is applied.
VERTICAL POSITIONING:	An oscilloscope control which will move the beam up or down on the screen. It is used to locate the beam on a graticule line.
VOLT-OHM-METER:	A portable, battery powered meter designed to measure voltage, current, and resistance. Abbrev. VOM

SCORE:

GRADE:

Name: ______

Date: ______

Period: ______

WORKSHEET

OSCILLOSCOPE CONTROLS AND INPUTS

Many manufacturers, such as Eico, Heathkit, Leader, Sencore, Tektronix, Lectrotech, Hewlett-Packard, Viz, Hickok, B&K Precision, etc., produce oscilloscopes. These companies unfortunately do not use common control designations; thus, while a scope control has a similar function on both an Eico and an Lectroteck scope they are labeled differently. For example, the vert attenuator control on the Eico-460 and the volts/div control on the Lectroteck - 55 scope have a similar function - that of adjusting vertical gain - but a different designation.

This exercise is designed to familiarize you with the name of the various scope controls, and their function. The chart below lists 1) control designation, 2) other common control names, 3) a column for you to indicate the name of the control, on your shop scope, which provides a similar adjustment and 4) a column for you to indicate the function of that control.

CONTROL DESIGNATION	OTHER COMMON CONTROL NAMES	NAME OF CONTROL ON YOUR SCOPE	CONTROL FUNCTION
BRIGHTNESS	BRIGHTNESS, INTENSITY		
FOCUS	FOCUS		
VERTICAL POSITIONING	VERTICAL POSITION, VERTICAL CENTERING		
HORIZONTAL POSITIONING	HORIZONTAL POSITION, HORIZONTAL CENTERING		
VERTICAL GAIN*	VERTICAL GAIN, VERTICAL AMPLITUDE, VERTICAL SENSITIVITY, VERTICAL ATTENUATOR, VERTICAL RANGE		

Name: ____________

Date: ____________

Period: ____________

HORIZONTAL GAIN*	HORIZONTAL GAIN, HORIZONTAL AMPLITUDE HORIZONTAL SENSITIVITY HORIZONTAL ATTENUATOR, HORIZONTAL RANGE		
SWEEP FREQUENCY	SWEEP FREQUENCY, COURSE FREQUENCY, FREQUENCY RANGE, SWEEP SELECTOR		
FINE FREQUENCY	FINE FREQUENCY, FREQUENCY VERNIER		
SYNC SELECTOR	SYNC SELECTOR, HORIZONTAL SELECTOR, SYNC INPUT		
SYNC AMPLITUDE	SYNC AMPLITUDE SYNC ADJUST LOCKING		
VERTICAL INPUT	V-INPUT INPUT		
HORIZONTAL INPUT	H-INPUT EXT./SYNC EXT. HORIZ. SYNC/HORIZ.		

* Many scopes utilize two gain controls, one to adjust gain in large steps, and a variable resistor to provide fine adjustments.

SCORE:

GRADE:

Name: ____________

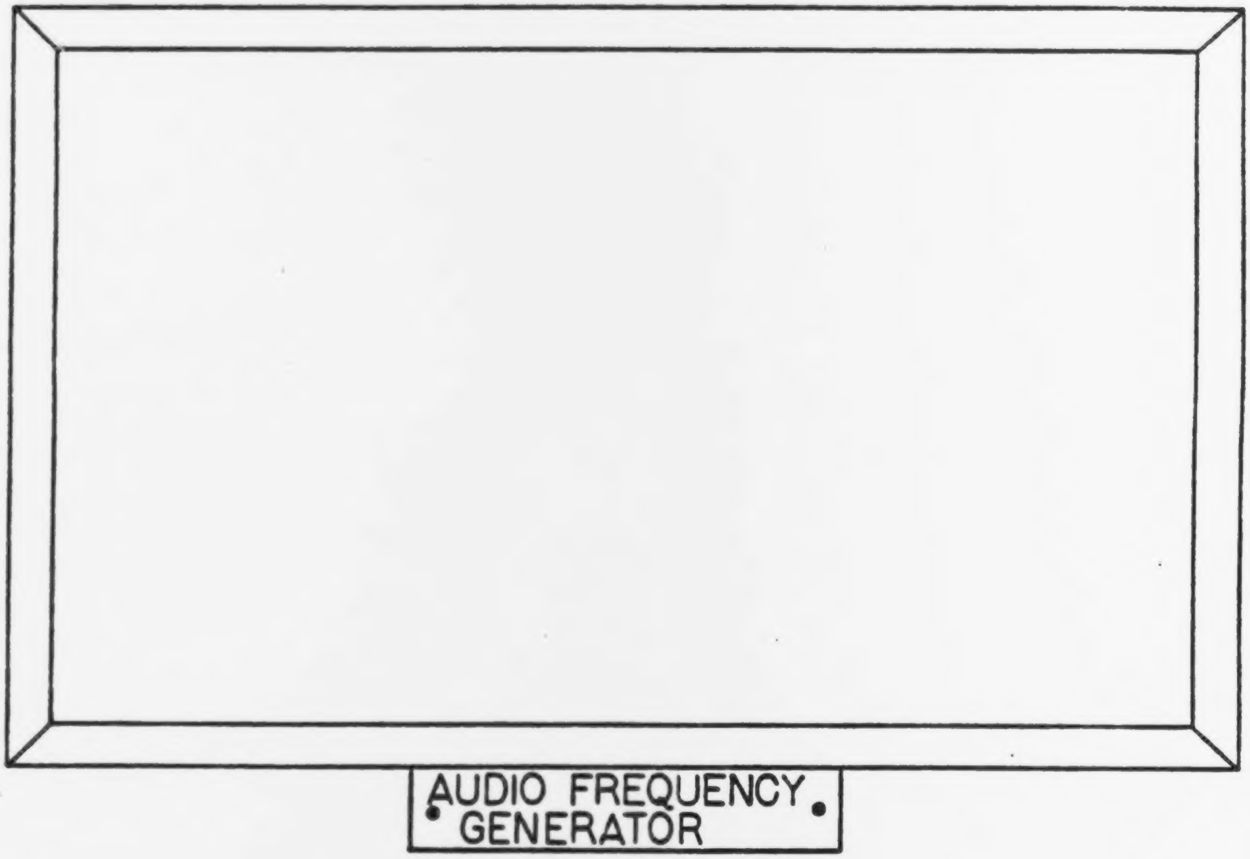
Date: ____________

Period: ____________

WORKSHEET

AUDIO FREQUENCY GENERATOR

In the space provided, make an accurate drawing of the shop audio frequency generator. Label all controls and terminals.



Utilizing the reference materials available:

1) describe the purpose of the AF generator.

2) list the controls found on the generator and indicate their function.

3) briefly describe the operating procedures, and precautions to be observed when using the signal generator.

Name: ____________________

Date: ____________________

Period: __________________

PURPOSE:

CONTROLS AND FUNCTION:

OPERATING PROCEDURES AND PRECAUTIONS:

SCORE:

GRADE:

Name: ____________

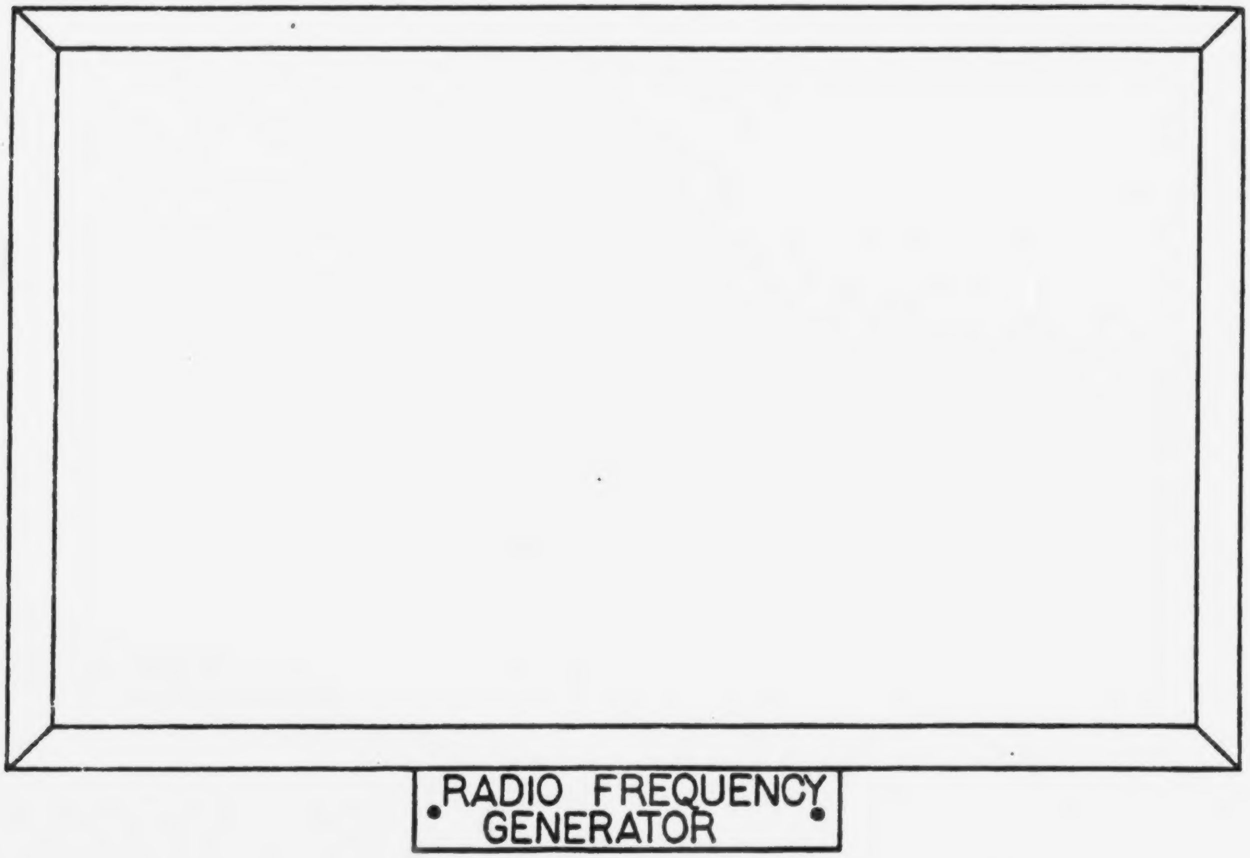
Date: ____________

Period: ____________

WORKSHEET

RADIO FREQUENCY GENERATOR

In the space provided, make an accurate drawing of the shop radio frequency generator. Label all controls and terminals.



Utilizing the reference materials available:

1) describe the purpose of the RF generator.

2) list the controls found on the generator and indicate their function.

3) briefly describe the operating procedures, and precautions to be observed when using the signal generator.

Name: ____________________

Date: ____________________

Period: ____________________

PURPOSE:

CONTROLS AND FUNCTION:

OPERATING PROCEDURES AND PRECAUTIONS:

SCORE:

GRADE:

Name: ____________

Date: ____________

Period: ____________

WORKSHEET

QUEST ACTIVITY

"UNIT 10"

Assume you were planning to start a small shop in your garage for hobby and repair purposes. You are interested in purchasing some test equipment and discovered that the following pieces of equipment are considered to be basic items necessary for troubleshooting circuit failures, and measuring circuit performance. (Items listed in general order of importance.)

1. VTVM or other accurate multimeter (TVM, DMM, ICVM, etc.)
2. Isolation transformer
3. RF signal generator
4. AF signal generator
5. Oscilloscope
6. R/C substitution box
7. Semiconductor tester
8. Variable output power supply (0-30V regulated)

On a separate piece of paper. List each item, and describe why you would need that particular piece of equipment in your shop. (What job will the test instrument perform?) Also, using the catalogs available in the room, look up, and price, the various pieces of equipment. Record the model, manufacturer, and price noting whether the equipment is assembled or in kit form.

Name: ____________________

Date: ____________________

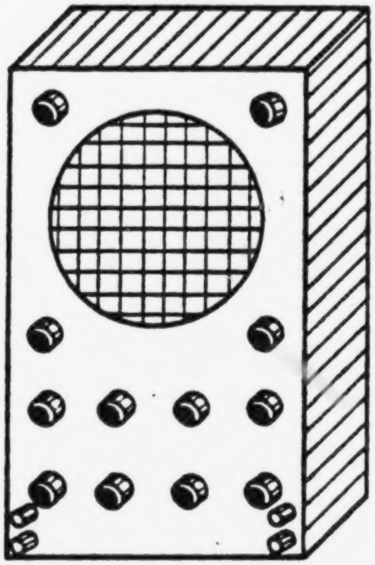
INFORMATIONAL HANDOUT Period: ____________________

TEST EQUIPMENT AND APPLICATIONS

THE OSCILLOSCOPE

GENERAL INFORMATION:

When examining an electronic circuit, it's important to know the voltage present at a test point, or the current flow through a particular component, but that's only half the story. You will also want to know what type of signal is flowing from point to point in the circuit. This is particularily important when checking audio, RF, SYNC or timing circuits. To SEE what's happening in your circuit you will use an oscilloscope. The scope allows you to visually examine and measure circuit signals or waveforms.



The heart of the oscilloscope is a cathode-ray tube, which is in many ways similar to the picture tube of a black-and-white television set. At the rear of the CRT is an electron gun. This assembly produces a narrow beam of electrons which are focused on to the screen of the CRT. When the electrons strike the phosphor atoms, which are coated on the inner face of the cathode-ray tube, light is produced. Internal circuitry is designed to sweep the beam horizontally across the face of the screen. When a signal is applied to the vertical input terminals, the beam is caused to deflect in the vertical direction, in proportion to the input voltage; that is, the larger the input voltage, the higher the beam will move in the vertical direction.

Name: ____________

Date: ____________

Period: ____________

To summarize, the beam is affected by two forces - 1) the internal horizontal sweep, and 2) the external input signal. These two forces, in combination, allow the beam to "trace-out" a picture of the input signal.

APPLICATIONS:

Besides providing a visual display of a waveform, an oscilloscope can perform other important functions or jobs. One of the simplest applications for the oscilloscope is the measurement of AC or DC voltages. Voltage measurements are indicated by the vertical amplitude of the wave, as compared to a graticule scale on the face of the scope. The scope can indirectly measure circuit current - that is if you are measuring the voltage across a resistor of known value, current can be computed by applying OHM's Law. The oscilloscope can also be used to measure the frequency of an AC wave. This measurement is a function of the horizontal length of the wave, and the sweep frequency. In the hands of a knowledgable individual, the oscilloscope can also be used to roughly check the sensitivity of a radio receiver, isolate distortion in an audio circuit, measure the bandwidth of a filter circuit, determine phase relationships between signals, and perform signal tracing operations.

SIGNAL GENERATORS

GENERAL INFORMATION:

Signal generators are test instruments used to supply an output signal at various frequencies and amplitudes. Generally, the outputs are either sinusoidal, square wave or amplitude modulated. The basis for a typical signal generator is an oscillator circuit. Such a circuit produces an AC output through the interaction of an (inductor-capacitor) or (capacitor-resistor) circuit, and an amplifier. The circuit design allows the operator to select the output frequency (over a certain range) and the output amplitude or voltage. Signal generators are divided into two major types: audio frequency and radio frequency generators.

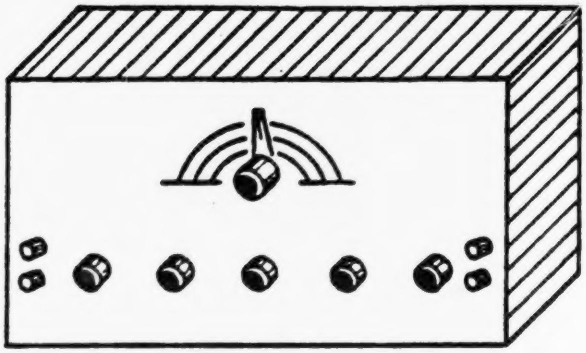
AUDIO FREQUENCY GENERATOR:

AF generators are designed to produce output signals which have a frequency range of approximately 20Hz to 200Hz. The particular output frequency is selected by using both a range switch or multiplier and a tuning dial. The amplitude of the output wave is adjusted by using a gain control. General-purpose AF generators are capable of producing both a sine wave and square wave output.

Name: ____________

Date: ____________

Period: ____________



APPLICATION:

An AF generator is used in testing and locating faulty stages in audio equipment. A typical tactic would be to inject an audio signal (using the AF generator) into a circuit and monitor that signal with a scope or signal tracer. Lack of output, or distortion of the signal would indicate a faulty stage.

RADIO FREQUENCY GENERATOR:

RF generators are designed primarily to produce a sinusoidal output signal that ranges from approximately 150kHz to 100MHz, again selectable by using a multiplier or band switch and tuning dial. In addition, the generator usually contains a fixed audio oscillator circuit. The addition of this circuit allows the output to be modulated (AF and RF signals mixed together) for testing of radio and TV circuits. The signal output level can be adjusted using the gain control. Typically, the output amplitude of an RF generator is low when compared to its audio frequency counterpart. The RF generator also requires special shielded probes to prevent the radiation of high frequency waves.

APPLICATIONS:

Alignment and adjustment, for maximum output, of a tuned circuit, in a radio, television, transmitter, or receiver.

INFORMATION

Information Sheet 1

OSCILLOSCOPE PROBES.

There are several types of scope probes for various applications. To get the most use out of your scope you need to understand these probes.

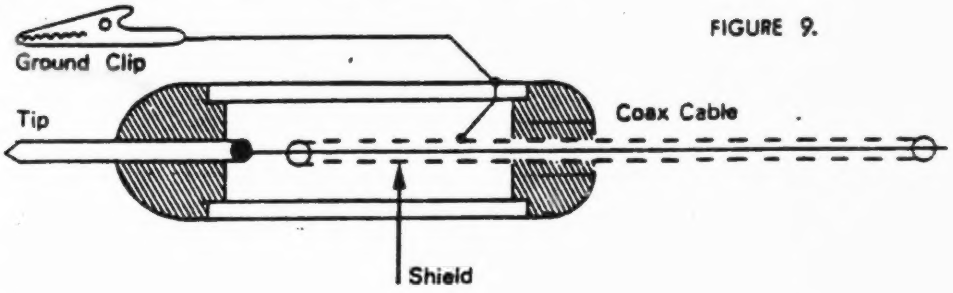
A. Direct Probe

In this catagory we include simple, single conductor test leads and coax equipped with alligator clips on one end and banana plugs or suitable connectors for the scope on the other end.

The unshielded leads are suitable for few applications since they pick up so much hum.

The coax with clips is a useful combination. For rapidly checking waveforms at several points in a circuit, a direct probe is used. Figure 9 shows a simple diagram of one.

FIGURE 9.



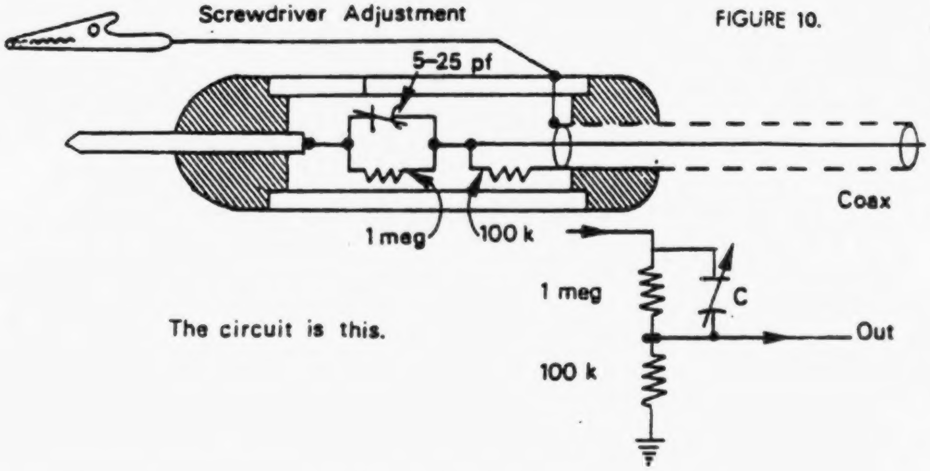
B. Low Capacity Probe

The direct probe and coax lead has a total capacitance of about 80 pf. This is enough to disturb the operation of many circuits, for example; TV sync circuits. For these a low capacitance probe is needed.

The low capacity probe is shown in Figure 10.

Information Sheet 1 continued.

FIGURE 10.

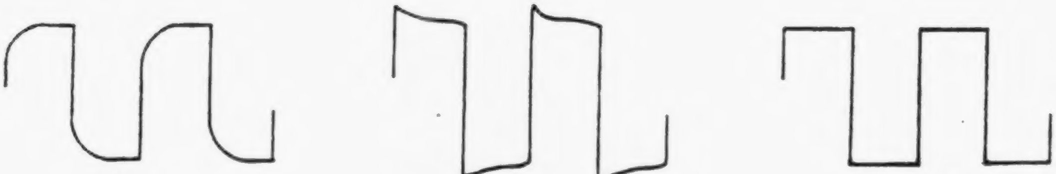


The circuit is this.

The capacitor compensates for the input capacitance of the scope and effectively reduces it to around 8-10 pf. The resistors provide some isolation and give a 10:1 attenuation meaning your scope sensitivity is effectively reduced by a factor of 10. Thus, if you measure .9V on the scope, the input signal really must be 9V. Remember to multiply your scope measurements by 10 when using the low capacity probe.

The capacitor is usually adjusted by applying a 10 KHz square wave and adjusting the capacitor to give as closely as possible a duplicate of the input square wave. See Figure 11.

FIGURE 11.



under compensated

over compensated

correctly compensated

Information Sheet 1 continued.

The low capacity probe should be used for testing high frequency, wide band, or high impedance circuits.

C. RF or Demodulation Probe

This probe is designed to show the modulation envelope and is used in tracing or checking modulated RF and IF signals. The structure is shown in Figure 12.

12.

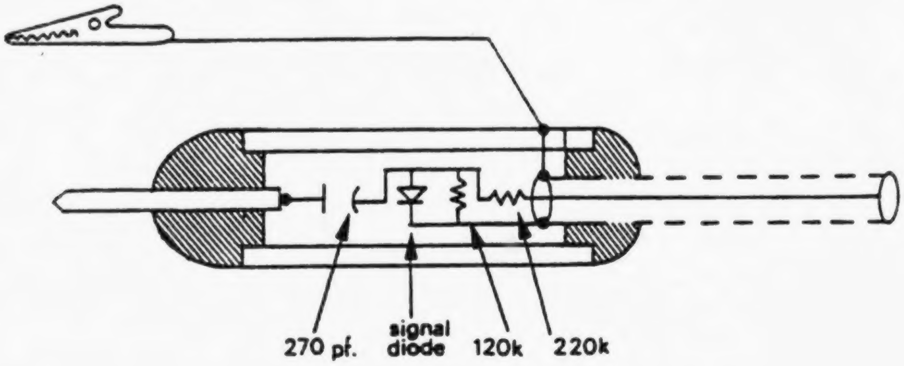


FIGURE 12.

THIS MATERIAL WILL BE INCLUDED LATER

INFORMATION SUMMARY

The oscilloscope is a very versatile instrument. You can observe the shape of a signal's waveform, measure its voltage, its frequency, and compare its phase with another signal.

To use a scope you first turn it on, adjust intensity and focus, center the grace, and connect to the signal source.

Voltage measurements require that you calibrate the scope and then measure the inpact signal by comparing its height with the height of the calibration voltage signal.

Phase and frequency measurements are done with Lissajous patterns. Measurements of phase give an ellipse. Measurements of the ellipse give figures which are then used to calculate the sine of the phase angle.

Direct probes are used for general work, low capacity probes in sensitive circuits, and RF probes in RF and IF circuits.

EXPERIMENT

OSCILLOSCOPE SET-UP PROCEDURE

EQUIPMENT AND MATERIALS:

General purpose oscilloscope and direct probe.

The first step in using an oscilloscope (scope) is to perform the set-up procedure. This involves adjusting the trace on the scope screen and connecting the probe from scope to test circuit. The procedure and an explanation follows:

1. Beam Adjustment Controls
    a. Locate the following controls:
        1. On-off or power switch
        2. Intensity or brightness control
        3. Focus control
        4. Horizontal, X-position control or H centering
        5. Vertical, Y-position control or V centering
    b. With power switch OFF, plug in the scope and proceed as follows:
        1. Turn power to ON and set all the beam adjustment controls to mid-range.
        2. As the scope warms up you should see a bright line, called a trace, on the screen. (Note: If you have only a bright dot on the screen, locate a control marked H gain or HOR gain and turn this clockwise until there is a line on the screen. NEVER leave a bright dot on the screen for very long since the chemical, called a phosphor, which provides the bright glow can be destroyed!)
        3. Now adjust the intensity control for a trace which is just clearly visible.
        4. With the focus control adjust the sharpness of the trace. Try focusing the trace at maximum brightness. Does it focus as well as at lower brightness?
        5. Adjust the horizontal and vertical position to center the trace.

2. Connecting the scope to a signal source.
    a. Locate the terminals marked V-input and GND. There are several ways these may be connected on different scopes. Some of these are:
        - banana jacks and plugs
        - microphone connectors
        - co-ax connectors
        - BNC connectors

    Your probe connector, of course, will have to match the scope connector.

EXPERIMENT

Experiment #2 and Information

HOW TO DISPLAY A STABLE WAVEFORM ON THE OSCILLOSCOPE

EQUIPMENT AND MATERIALS:

1. 1-general purpose oscilloscope
2. signal source designated by instructor

PROCEDURE:

The next step in using the scope is to stabilize the waveform on the screen.

1. Height and Width Adjustment
    a. Locate the following controls:
        1. Vert. Atten., or V-Range. This control can be considered the coarse sensitivity control. It is generally a switch having several positions.
        2. Vert. Gain, Y or V-Gain, V Cal. This can be considered a fine adjustment for now. Later you will see how this control is used to calibrate the scope for voltage measurements.

    b. Connect the scope to a signal source.

    c. Operate the V-Atten. and V-Gain controls and observe their effect on the waveform. Set these controls to give a waveform which is roughly 1/3 to 1/2 of the height of the screen. Do not be concerned if the waveform is blurred or appears to move. You will stabilize the waveform in the next step.

    d. Locate the Horiz. Gain control. Adjust this control to set the width of the trace to just smaller than the screen.

2. Stabilizing the Waveform -- Theory
    In this step you will be synchronizing the input signal and the electron beam motion which forms the trace. Before learning how to do this you need to know a little more about how the scope works.
    a. Sweep-The line across the screen, which you know as the trace, is caused by a beam of electrons moving from left to right across the screen. This motion is called the "sweep" and its frequency is call called the "sweep frequency". The sweep repeats its motion at a

Experiment #2 continued.

regular rate. This sweep frequency is adjustable. The controls which do this are usually called Sweep Selector or Coarse Frequency and Sweep Vernier or Fine Frequency. These control a circuit called the Sweep Generator.

b. Synchronizing--The input signal and the sweep must be in step or synchronized. This means that the start of the sweep must always come at the same point in the signal waveform. If the sweep and signal are out of "sync", the waveform appears to move across the screen. To sync the sweep and signal, two conditions need to be met. First the sweep frequency must be set close to the frequency of the waveform being observed. By close we mean from equal to the frequency to roughly 1/10 the frequency. This is done by setting the coarse frequency first to the setting nearest the signal frequency and these carefully adjusting the Sweep Vernier to stabilize the wave. The wave stabilizes when you set the sweep frequency so that the signal frequency is an integral multiple of it.

The second condition is that the sweep generator must start its sweep at the same relative point on the signal waveform. This is done by connecting a small amount of the input signal to the sweep generator and letting this start the sweep. This insures that the sweep starts at the proper time. The control marked SYNC SELECTOR, OR HOR SELECTOR selects this sync voltage. The + or - positions select a portion of the input signal for sync. The Ext. position allows an external voltage to be used for sync. The 60 Hz or line position uses the 60 Hz line frequency as the sync.

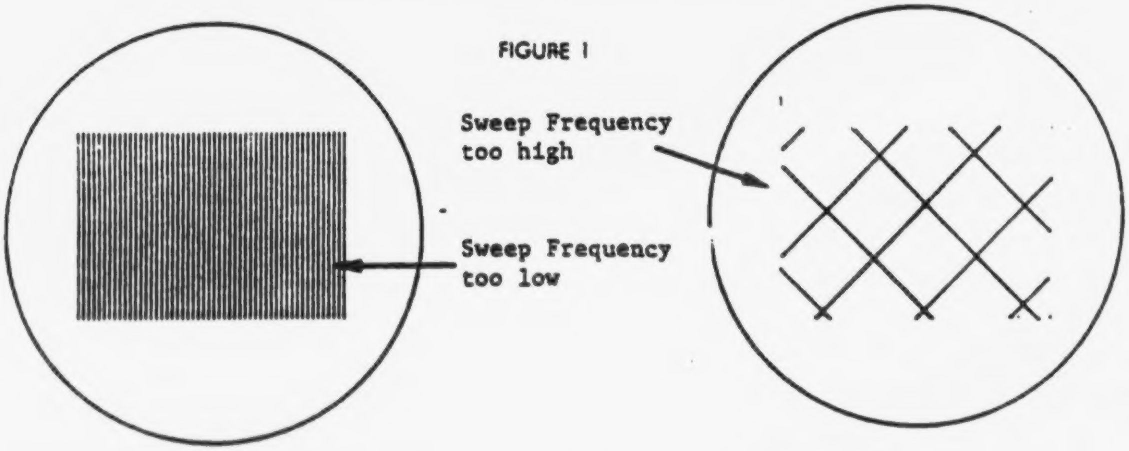
To summarize: Synchronizing the scope means that you set the sweep frequency to a value near that of the input frequency and select, usually, a portion of the input signal to start the sweep generator at the same point in the waveform. It is highly recommended that you look up a reference on the oscilloscope and study it in greater depth.

c. Practice in synchronizing the waveform.
1. Locate the Sweep Selector or Coarse Frequency, the Sweep Vernier or Fine Frequency and the Hor. Selector or Sync Selector controls.
2. Set the Sync Selector to +

Experiment #2 continued.

3. With a signal input to the scope, adjust the Coarse Frequency to the range closest to the frequency of the input signal. Then adjust the Sweep Vernier to stabilize the waveform. If you cannot stabilize the waveform, the Coarse Frequency is in the wrong range. The diagrams in figure 1 will help you to know whether to increase or decrease the sweep frequency.

FIGURE 1



Appears as a blur because too many cycles are squeezed into the trace.

"Braided" appearance

Usually a 2 to 4 cycles display is the most useful.

4. Practice these steps until you can quickly do them without hesitation.

EXPERIMENT

Experiment #3 and Information

MEASURING VOLTAGES

EQUIPMENT AND MATERIALS:

1. 1-general purpose oscilloscope
2. AC signal source
3. External calibrated voltage source if needed.
4. Instruction manual for scope.

The scope is very useful in making voltage measurements, particularly of complex waveforms which cannot be accurately measured on the VOM or VTVM. Applications of voltage measurements include gain of amplifiers, input and output of stages, microphone output, voltage amplitude of portions of waveforms and many others.

AC Peak Voltage

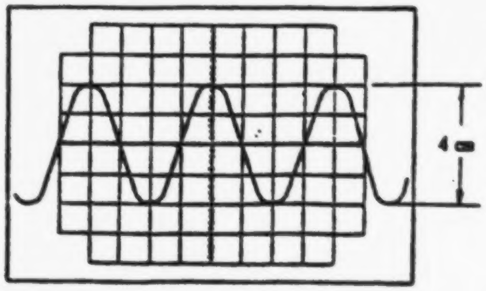
When it is desired to determine only the AC voltage component of the signal being measured, set AC-GND-DC switch [illegible] at AC. and , from the amplitude on the screen at this time, calculate the peak voltage as follows:

Measurement using a X 1 probe or lead wire

Peak voltage (Vp-p) = Value indicated at VOLTS/ cm . X amplitude (cm.)

Measurement using a X10 probe

Peak voltage(Vp-p) = Value indicated at VOLTS/ cm . X amplitude (cm .) X 10



As shown above, the voltage of the signal being measured is calculated as follows:

If VOLTS/ cm = 0.05V/ cm ,

Peak voltage when a X1 probe or lead wire is connected directly = 0.05V/ cm x4 cm . = 0.2Vp-p

Peak voltage when using a X10 probe = 0.05V/cm X 4 cm X 10 = 2Vp-p

If the input waveform is a sine wave, the measured voltage (p-p) can be converted to effective voltage (rms). The following relationship exists between the peak voltage (Vp-p) and the effective voltage (Vrms).

$$\text{Effective voltage (Vrms)} = \frac{\text{Peak voltage (Vp-p)}}{2\sqrt{2}}$$

2Vp-p, for instance, is converted to rms value as follows:

$$\frac{2\ \text{Vp-p}}{2\sqrt{2}} = \frac{2}{2 \times 1.414} = 0.707\ \text{Vrms}$$

Notes
1. When switch ⑫ is set at "AC," the low frequency characteristic is attenuated to −3dB at 2Hz. Also, note that no AUTO synchronization is accomplished at 50Hz or less.
2. When measuring a voltage, be sure to turn the VARIABLE knobs ⑪ fully clockwise to ↻CAL'D.

DC Voltage

Use AUTO sweep, set AC-DC-GND switch ⑫ at GND. The trace (bright line) should show OV. Set the trace to a position for easy measurement on the screen. Next, set the AC-DC-GND switch at DC and read the shift of the trace on the screen. Adjust the VOLTS/cm switch so that the trace will be displayed on the screen. An upward shift of the trace (bright line) represents (+) and a downward shift (−).

From the shift of the trace on the screen, the voltage of the signal being measured is calculated as follows:

voltage when a ×1 probe or lead wire is connected directly

Voltage (V) = Value (V/ cm) indicated at VOLTS/ cm × shift (cm)

Voltage when using a ×10 probe

Voltage (V) = Value (V/ cm) indicated at VOLTS/ cm × shift (cm) × 10

Example

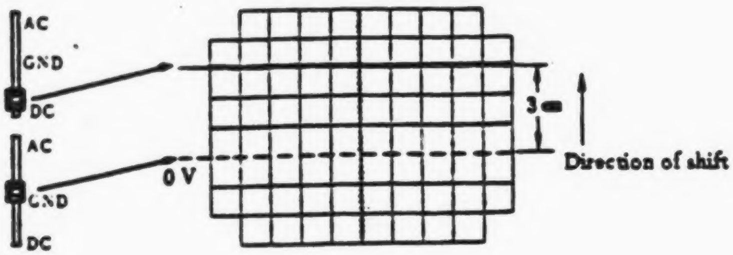
If the range indicated at the VOLTS/ cm is 2V/ cm , the voltage of the signal being measured is calculated as follows:

When a ×1 probe or lead wire is connected directly

2V/ cm × 3cm = +6V

When using a ×10 probe

2V/ cm × 3cm × 10 = +60V



DC + AC Peak Voltage

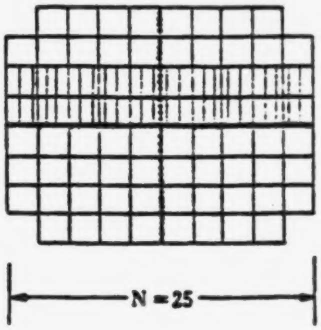
Make measurement using the "DC" and the "GND" as in the case of the measurement of DC voltage. If the range indicated at the VOLTS/ cm is 0.1V/ cm , the voltage of the signal being measured is obtained as shown below.

$$\text{Frequency F (Hz)} = \frac{\text{Number of pulses N}}{\text{Value indicated at TIME/cm} \times \text{Reciprocal of magnification} \times 10\text{ cm}}$$

Where, the reciprocal of magnification of the magnifier is 0.2 when magnified and 1 when not magnified.

For example, in the left-hand figure.

TIME/ cm : 1μs/ cm
Magnifier : ×1



Then,

$$\text{Frequency F (Hz)} = \frac{25}{1\mu\text{ sec/cm} \times 10\text{ cm} \times 1} = 2.5\text{MHz}$$

14.

Experiment #4 and Information

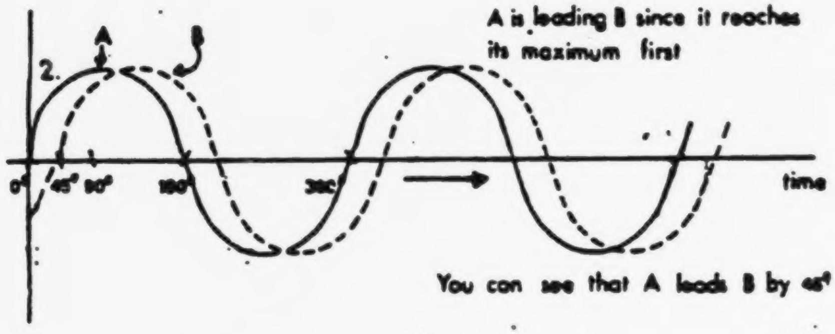
MEASURING PHASE RELATIONS

EQUIPMENT AND MATERIALS:

1. 1-general purpose oscilloscope
2. AC source (6v to 12v)
3. Inductor, 8 to 14 Henry
4. Capacitors .1 μF, .01 μF, .001 μF
5. Resistors, ½ watt of about 4.7K, 15K, 22K, 47K, 470K

When you study AC circuits you will learn that it is quite common for the AC voltage in one part of the circuit to reach its positive maximum at a different time than the AC voltage in another part of the circuit. We say that these voltages are "out of phase". They could look like Figure 2 on our scope if signals were displayed at the same time:

FIGURE 2



A is leading B since it reaches its maximum first

You can see that A leads B by 45°

You will learn why these phase differences can exist when you study AC circuits.

With the scope we can make a fairly good measurement of this phase difference.

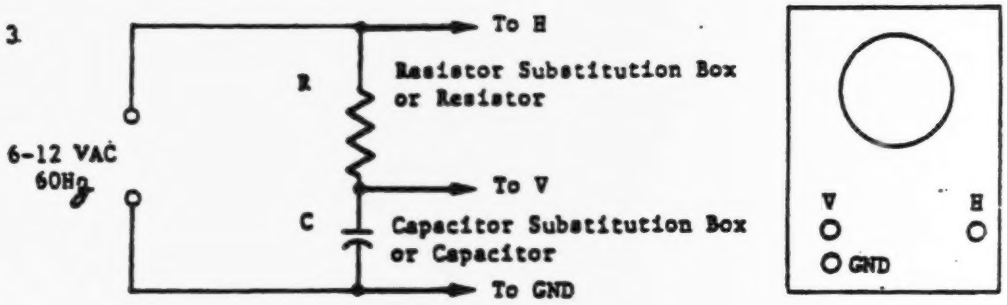
PROCEDURE:

1. On your scope locate:
   a. Hor. Input connector. This is usually a 5-way connector. These connectors allow several manners of connection, the banana plug being best.

Experiment #4 continued.

b. Sync or Hor Selector. Set this control to Ext. Hor. (not Ext Sync). This disconnects the sweep generator from the scope and connects the Hor. Input to the horizontal amplifier which is controled by the Hor. Gain control.

2. Connect this circuit.


3
To H
R
Resistor Substitution Box
or Resistor
6-12 VAC
60Hz
To V
C
Capacitor Substitution Box
or Capacitor
To GND
V
H
GND

3. In order to make this measurement, the gain of the horizontal and vertical amplifiers must be equal. This is done as follows:
   a. Set the value of R to 47K or else connect a 47K resistor.
   b. Temporarily replace C with a resistor equal to R.
   c. Turn on the scope. After warm up you should see a diagonal straight line.
   d. Turn the V-gain to zero giving a horizontal line. Adjust the H-gain to give a convenient length horizontal trace. (2 or 3 inches is suggested)
   e. Do not disturb the horizontal gain, disconnect the lead going to the H-input.
   f. Increase the V-gain to give a vertical line equal in length to the horizontal line. Do not disturb this setting.
   g. Now reconnect the Horizontal input. You should observe a line that is 45° from horizontal. Center this with the H and V position controls to look like, Figure 4.

Experiment #4 continued.

FIGURE 4.

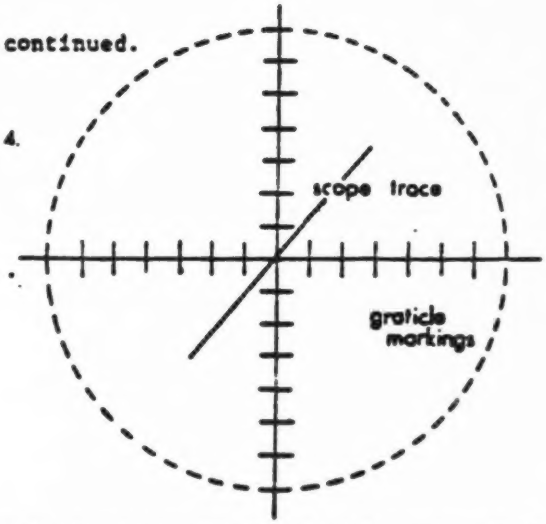
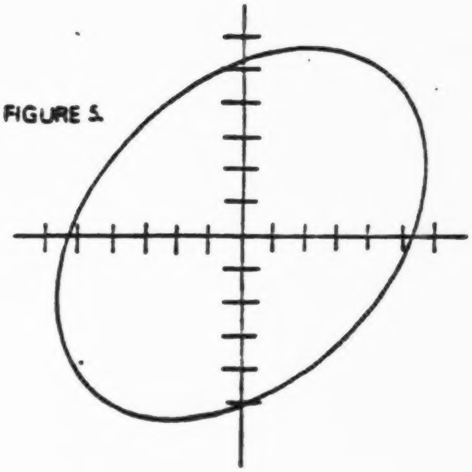


FIGURE 5.



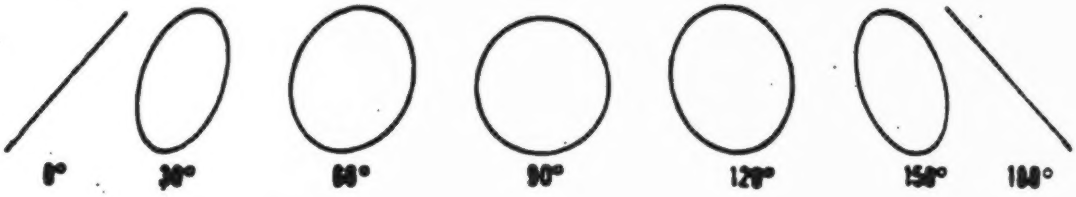
h. Remove the temporary resistor and reconnect the capacitor.

4. You should now be observing an ellipse on the screen, as in Figure 5. For this experiment any combination of R and C which gives a fairly "fat" ellipse will be suitable. Avoid a narrow ellipse since the accuracy of the phase measurement will be poor.

EXPLANATION OF PATTERN-

This is called a Lissajous pattern. It results from the "mixing" of two sine waveforms, one controlling the horizontal motion of the beam and the other controlling the vertical motion. The result, when both waves have the same frequency, is an ellipse display. The shape of the ellipse depends on the phase relationship of the two waveforms. Several patterns are shown in Figure 6 as examples:

6.



Phase relations

EXPERIMENT

Experiment #5 and Information

MEASURING FREQUENCY WITH THE LISSAJOUS PATTERN

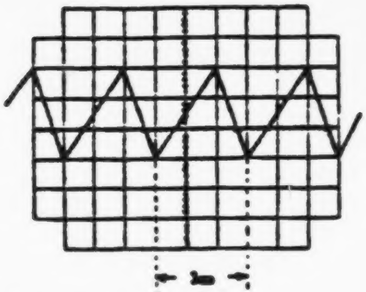
Time Interval Measurement

The time interval T is calculated as follows:

Time T (sec) = Value indicated at TIME/cm × Distance on the screen × Reciprocal of magnification of the magnifier

The reciprocal of magnification of the magnifier is 1 when not magnified and 0.2 when magnified.

The time interval T in the left-hand figure is calculated as follows:



TIME/cm = 0.5 (0.5mS/cm)

When the magnifier is ×1,

T = 0.5 mS/cm × 3 cm × 1 = 1.5msec

When the magnifier is × 5

T = 0.5mS/cm × 3 cm × 0.2 = 0.3msec

Frequency Measurement

There are two methods using waveforms to measure frequency. One is to calculate the frequency from the time of 1 period, and the second method is to count the number of complete waveforms, or pulses, over the 10 cm horizontal width.

As regards to first method, the time of 1 period, T, is measured as given in the Section 6-5 above, and its reciprocal is the frequency F.

$$\text{Frequency F (Hz)} = \frac{1}{\text{T (seconds)}}$$

$$= \frac{1}{\text{Value indicated at TIME/cm} \times \text{distance of 1 period on the screen} \times \text{reciprocal of magnification of the magnifier}}$$

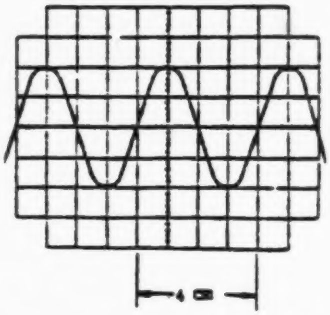
For example, in the right-hand figure,

TIME/cm : 0.5mS/cm

Magnifier (MAG) : ×1

Then, T = 0.5mS/cm × 4cm × 1 = 2msec

$$\text{Frequency F (Hz)} = \frac{1}{\text{T (sec)}} = \frac{1}{2 \times 10^{-3}} = 500\text{Hz}$$



As regards the second method, that is, counting the number of complete waveforms, or pulses, over the 10 cm horizontal width, the frequency is calculated as follows. 18

NAME:____________________

LAB DAYS/HRS:_______________

INSTRUCTOR:_______________

ELECTRONICS 30 LAB SHEET #11

Learning to Use the Oscilloscope, Function Generator, and the Frequency Counter

Reading assignment:

(GROB) pgs. 616 -617.
Chapter 16 and 17.

----------INSTRUCTIONS----------

As you complete the projects in this Lab Sheet please keep a record of the time you take to complete each project and any errors or difficulty you encounter. When you have completed all the projects tear off this page and turn it in to the tool room. These sheets and your comments will be used to correct and improve future Lab Sheets. Thanks for your help.

PROJECT NUMBER	DATE STARTED	DATE COMPLETED	APPROXIMATE HRS TO COMPLETE	COMMENTS RECOMMENDATIONS

AMERICAN RIVER COLLEGE
ELECTRONICS DEPARTMENT

3/84/lfr

ELECTRONICS 30

Learning to Use the Oscilloscope, Function Generator and the Frequency Counter

INTRODUCTION

In the hands of a skilled technician, the Oscilloscope, Function Generator, and Frequency Counter are very versatile and useful instruments. You should be especially aware of what it is you need to do in these projects, and how you can do it with the test instruments. Pay particular attention to the capability of your equipment and which controls you must operate to use that capability. Learn the function of all controls soon, and practice using them throughout the remainder of your electronics program. One of the best indicators of a good technician is her/his knowledge and skill using test equipment. Employers often select employees on the basis of their ability to use test equipment.

While using the test equipment in these projects, pay particular attention to the way that controls are grouped together, color coded, and marked off with lines on the front panel. You should start immediately to recognize the relationships between the different controls and their functions. DO NOT JUST TURN KNOBS UNTIL YOU GET SOMETHING CLOSE TO WHAT YOU WANT. You are on the way to becoming an outstanding technician, so learn the function of each control and use your test equipment efficiently and effectively.

PART A: OSCILLOSCOPE FAMILIARIZATION.

Since different oscilloscopes are used in the different lab rooms, your instructor will brief you on the operation of your particular equipment. This Lab Sheet will be directed to room 320, the primary E30 lab.

PROCEED TO PART B ONLY AFTER YOU HAVE BEEN BRIEFED BY THE INSTRUCTOR ON THE USE OF THE EQUIPMENT.

NOTE: Attachment 1 (last page) shows an abbreviated turn-on procedure for the Tektronix 5110 Oscilloscope.

PART B: USING THE OSCILLOSCOPE TO MEASURE VOLTAGE.

PROJECT 1: Measuring peak-to-peak voltage with the Oscilloscope.

INTRODUCTION

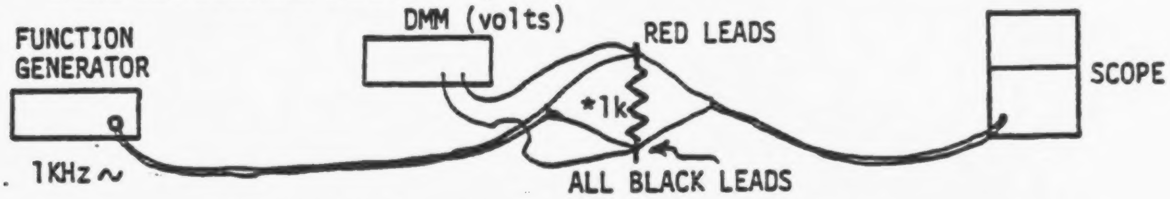
The face of the scope cathode ray tube (CRT) is marked off in 1 centimeter (cm.) squares to help you make voltage and time measurements. These grid lines on the CRT are called the "graticule".

The Oscilloscope trace is deflected up and down by voltage applied to the vertical input amplifier. Since vertical deflection is proportionate to voltage, beam deflection height can be used to measure voltage. You will use the vertical markings on the graticule to measure voltage. Later you will use the graticule horizontal markings to measure time.

A 1k resistor from your AC/DC Board is used for a load for the Function Generator. Be sure to set the DMM for AC VOLTS.

INSTRUCTIONS

1. Connect the circuit below. INSURE ALL BLACK LEADS ARE CONNECTED TO THE SAME ELECTRICAL POINT.



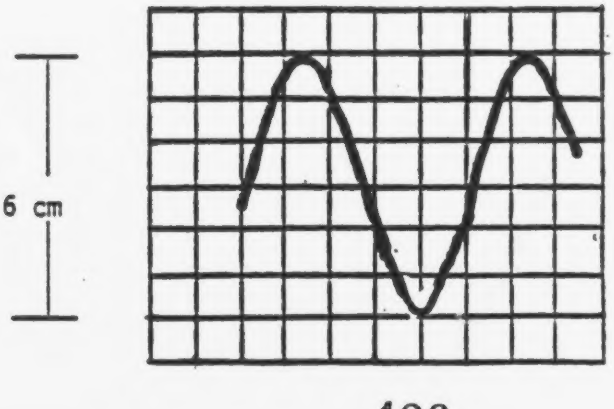
2. Turn on the Function Generator and adjust its FREQUENCY control for approximately 1kHz. Adjust its AMPLITUDE control for 2.12 volts (rms) as shown on the DMM. NOTE: Get as close to 2.12 volts as you can without spending too much time.

3. Adjust the scope for a display as high as you can read on the scope. The display need not be a stable sine wave at this point as you are just setting the vertical gain control. HINT: To display 2.12 volts (rms) as large as possible, the scope vertical amplifier gain (v/cm. knob) should be set on "1v/cm.".

4. Make necessary adjustments to the horizontal amplifier controls to stabalize the display and show several cycles of the signal. Always make any adjustments necessary to the horizontal controls to stabalize the display.

Here is an example of how your scope should appear. It is OK if you have more cycles of the signal displayed, since you are interested in amplitude only (i.e. vertical deflection only).

V/cm control setting (range)	signal height	voltage (p-p) cms(deflection)X range=Ep-p
2 v/cm	6 cm.	6 cms X 2 v/cm = 12v(p-p)



5. The sinewave will be displayed 6 cm.. high (i.e. six major divisions vertically on the graticule). The voltage is therefore 6 volts peak-to-peak.

Erms X 1.414 = Epeak and Epeak X 2 = Epeak-to-peak.

6. Change the "1 v/cm." control to 5 v/cm., and other settings, and observe that the voltage is less accurate or impossible to read.

7. Try another example: Reset the Function Generator AMPLITUDE control to 3.2 volts (rms) as indicated by the DMM.

8. Using the scope, measure the peak-to-peak voltage of 3.2 volts (rms). Change the v/cm. knob to 2 v/cm. Record: 3.2 v(rms) = __________v (p-p).

Notice that the 1 v/cm. setting caused the signal to be larger than the scope face. Changing it to 2 v/cm gave you the biggest readable display.

9. Try more examples now using this procedure. The lettered steps correspond to the lettered columns in the table.

a. Using the same circuit, set the Function Generator AMPLITUDE to the DMM voltage (rms) shown.

b. Adjust the scope vertical gain control (v/cm.) for a display which is as high as possible, yet not off the top or bottom.
Adjust the horizontal amplifier controls for a stable display of several cycles.

c. Use the graticule to measure the peak-to-peak voltage of the signal.

d. Calculate the rms voltage of the peak-to-peak signal on the scope. Compare this calculated rms value to the rms value measured on the DMM.

NOTE: The first entry in the table is an example.

TABLE 1.

(a.)	(b.)	(———— c.	————)	(d.)
DMM volts	Scope v/cm. knob set on: (range)	signal height (cm.)	volts (p-p)= cm. x range.	V (rms) = $\frac{Vp-p}{2}$ X .707
6 v rms	.5 v/cm.	3.5 (approx)	17.5 v p-p	6.2v rms
8 v rms				
9 v rms				
7.5 v rms				
.7 v rms				
.45 v rms				
1.4 v rms				

10. Are your calculated volts in the far right column similar to the DMM volts in the left column? YES/NO

Did both lab partners actually make measurements and adjustments? YES/NO

PROJECT 2: Using the Oscilloscope to adjust the Function Generator to a specified peak-to-peak voltage output.

INTRODUCTION

Now you will set the Function Generator AMPLITUDE control for a specified peak-to-peak voltage while observing the scope. You will then verify the voltage with the DMM, which indicates volts rms.

First, you will want to determine the height that the voltage should deflect; you can then adjust the AMPLITUDE to that height. In the following case, where you are setting a 7 volts peak-to-peak signal, it is easy since each centimeter line on the graticule represents 1 volt. You should set the 7 volt p-p signal for a scope display 7 cm. high. However, it is a little more complex to adjust the amplitude for other settings of the vertical gain control. Here is one way that you can do it:

$$\text{Deflection in cm.} = \frac{\text{Volts p-p}}{\text{range setting (i.e. 1 v/cm., .2 v/cm. 5 v/cm. etc.)}}$$

NOTE: Maximum height of the graticule is 8 cm.

INSTRUCTIONS

1. Set the scope vertical gain control to "1 v/cm.". While observing the scope, adjust the Function Generator AMPLITUDE control for 7 volts peak-to-peak.

2. Calculate the rms value of 7 volts (p-p):____________v (rms)

3. Use the DMM to verify that you have the AMPLITUDE set as specified.

Does the DMM read the same value calculated in step 2? YES/NO

4. Using the same circuit and procedures, set the Function Generator AMPLITUDE to each of the specified voltages indicated below. Use the vertical amplifier range giving the most accurate reading on the scope (i.e. Keep the display as large as possible.

Volts (p-p)	Calculated volts (rms)	DMM Measured volts (rms)
.707	____________volts (rms)	____________volts (rms)
1.0	____________volts (rms)	____________volts (rms)
2.83	____________volts (rms)	____________volts (rms)
20.0	____________volts (rms)	____________volts (rms)

5.5	__________volts (rms)	__________volts (rms)
15.0	__________volts (rms)	__________volts (rms)
8.5	__________volts (rms)	__________volts (rms)
18.5	__________volts (rms)	__________volts (rms)
4.0	__________volts (rms)	__________volts (rms)

Did you learn how to keep the display large while adjusting the amplitude?

Did both lab partners do all the measurements and adjustments? YES/NO

How did you do? (circle one) Super OK #$%@*&!

PROJECT 3: Using the Oscilloscope to adjust the Function Generator to a specified rms voltage output.

INTRODUCTION

In this project, you will set the Function Generator AMPLITUDE control for a specified rms voltage while observing the scope. You will then verify the voltage with the DMM. (Remember that the DMM reads rms voltage.)

Because it is impossible to accurately read rms values directly on the scope, you must first calculate the peak-to-peak voltage. Then, you have to determine how high a sine wave of that value will be. If you adjust the AMPLITUDE for a display that high on the scope, you will have the specified rms voltage output from the Function Generator.

$$\text{Volts peak-to-peak} = \text{Volts (rms)} \times 1.414 \times 2$$

Once the peak-to-peak voltage is known, the procedure for setting it up is the same as in Project 2 above.

INSTRUCTIONS

1. Calculate the peak-to-peak voltage for each specified rms voltage given below.

2. Calculate the required vertical amplifier gain control setting (v/cm.) and the vertical deflection height. (Remember the maximum height of the graticule is 8 cm.) Record your calculations in the appropriate columns.

3. Adjust the Function Generator AMPLITUDE for the calculated height on the scope.

4. Verify that you have set the correct peak-to-peak voltage by using the DMM.

(The first entry in the table below is an example.)

Table 2

Volts (rms)	Volts (p-p) (calculated)	Scope v/cm. knob will be set on: (range)	Signal height will be: (cm.)	DMM measured volts (rms)
4	11.3	2	5.65	3.999
9				
.5				
7.5				
1.5				
8				
.75				

Is the DMM measured value the same as the given rms value? YES/NO

PROJECT 4: Measuring the Function Generator output amplitude.

INSTRUCTIONS

1. Measure the maximum voltage output from the Function Generator using the scope. Calculate the rms value from the measured peak-to-peak value.

Maximum volts: ________v p-p ________v rms

2. Measure the minimum voltage output from the Function Generator using the scope. Calculate the rms value from the measured peak-to-peak value. NOTE: Some Function Generators may go to 0 volts. In this case you will not see any sine wave but may see noise or interference from the lab lights when set on 1 mv/cm. or higher gain setting.

Minimum volts: ________v p-p ________v rms

3. Did you turn the AMPLITUDE control fully clockwise to get maximum voltage output from the Function Generator? YES/NO

Did you turn the AMPLITUDE control fully counter clockwise to get minimum voltage output from the Function Generator? YES/NO

SUMMARY

These projects should have allowed you to gain skill in measuring voltage with the scope. You will learn best through experience and by studying the function of the different controls. To become an outstanding technician requires a great amount of "hands on" experience. Be sure you are actually working with the test equipment and not just "watching how it is done".

You should have noticed several things in these projects which are important about this scope. The first is that the signal becomes unstable when it is displayed only 1 or 2 cm. high. The sine wave tends to move left or right or be "scrambled" looking when the vertical amplifier gain control is set too low. Sometimes the synchronizing control ("LEVEL control on the Tektronics scope) will help to lock-in the signal. However, when possible display the signal as high as you can to insure the scope stays stable.

Secondly, on the very high gain settings (1 mv/cm., 2 mv/cm. etc) there is noise displayed which can hide a very small signal. There isn't much you can do about it except gain experience in recognizing it is there and work with it the best you can.

PART C: USING THE OSCILLOSCOPE TO MEASURE TIME AND FREQUENCY.

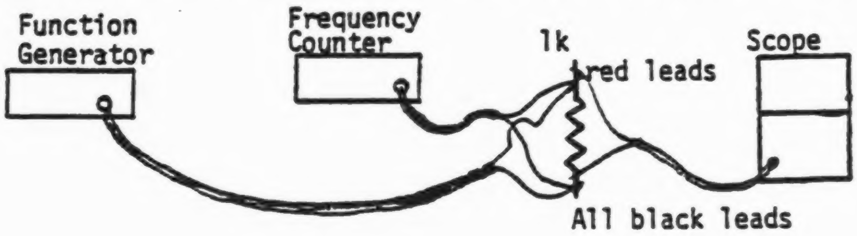
PROJECT 1: Measuring frequency using the scope.

INTRODUCTION

The scope displays voltage in relation to time. You will now use this capability to approximate frequency. You will verify your accuracy with the Frequency Counter.

INSTRUCTIONS

1. Connect the circuit shown below. Make sure all black ground leads are connected to the same electrical point and none are connected to any red lead.



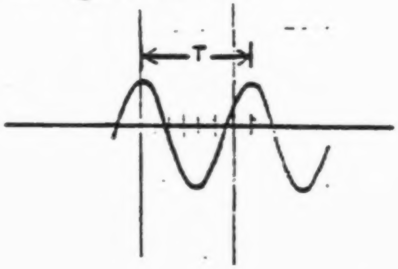
2. Set the Function Generator output FREQUENCY to 1 kHz. Use the Frequency Counter to verify frequency accuracy.

3. Adjust the Function Generator output AMPLITUDE to 2 volts peak-to-peak on the scope. Adjust the horizontal amplifier controls to display several cycles of the sine wave.

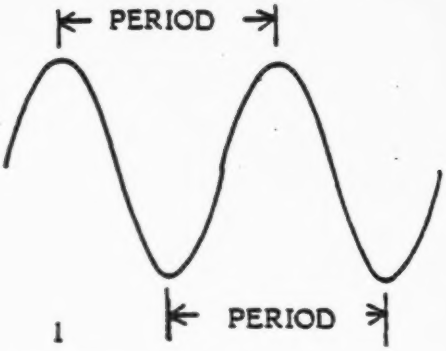
4. Using the scope HORIZONTAL graticule scale, measure the TIME duration of one cycle of the sine wave. This is called the "Period" of the sine wave. Here is the procedure you can use:

   a. Position the display so the peak of one cycle is on a graticule line. Use the POSITION control on the Horizontal Amplifier to do this.

   b. Count the calibrated lines to the next sine wave peak. Record:________#cm.



c. Read the setting of the HORIZONTAL SWEEP SPEED (SECONDS/DIV) control
Record:__________ sec/div.



d. Calculate the Period of the signal.

Period = #cm. X (sec/div) = __________seconds.

5. Calculate the Frequency of the sine wave.

$$\text{Frequency} = \frac{1}{\text{Period}} \quad \text{and} \quad \text{Period} = \frac{1}{\text{Frequency}}$$

6. Is your calculated frequency the same as the measured Frequency? YES/NO

7. If the answer to step 6 was "YES", continue. If "NO", repeat the above steps until you can measure frequency using the scope.

8. Set the Function Generator to each of the frequencies below with 2 volts p-p output as before. Calculate the Period for each and then measure it using the scope. Record those two findings in the appropriate column. Lastly calculate the Frequency from the measured period and record it in the right column.

Frequency	Calculated Period	Measured Period	Calculated Frequency
250 Hz	__________	__________	__________
400 Hz	__________	__________	__________
850 Hz	__________	__________	__________
2.5 kHz	__________	__________	__________
10 kHz	__________	__________	__________
45 kHz	__________	__________	__________
90 kHz	__________	__________	__________
175 kHz	__________	__________	__________
250 kHz	__________	__________	__________
625 kHz	__________	__________	__________
875 kHz	__________	__________	__________

Highest frequency out of Function Gen.__________ __________

9. Do the calculated frequencies agree (+ or - 10%) with the measured frequencies? YES/NO

PART D: SPECIAL FEATURES OF A HIGH QUALITY OSCILLOSCOPE.

PROJECT 1: Checking Scope Calibration.

INTRODUCTION

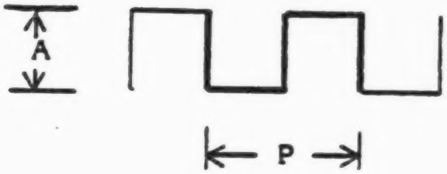
Most good quality scopes have an internal signal of precise value to use for checking scope calibration. For example the Tektronics 5110 has a 400 mv, 120 Hz square wave. This signal is always available for use at the CALIBRATOR terminal bar immediately under the POWER switch. If you ever need to check the calibration of a different type of oscilloscope, which has no calibrator output, you can use a Funcion Generator, DMM, and Frequency Counter.

In this project you will learn how to check the calibration of the Tektronics 5110 Oscilloscope as well as other models.

INSTRUCTIONS

1. Connect the red lead of your scope vertical amplifier input cable to the CALIBRATOR terminal bar under the POWER switch.

2. Adjust the scope for a stable display. You should get a square wave like this:



3. Measure the amplitude of the signal.
Amplitude__________mv. (A)

4. Measure the period of the signal.
Period:__________ms. (P)

5. Calculate the frequency.
Frequency:________Hz.

6. Calculate the accuracy of your scope for measuring voltage.

$$\%\ \text{error} = \frac{\text{Signal In} - \text{Measured volts}}{\text{Signal-In}} \times 100$$

NOTE: Signal In = 400mv. for Tektronics 5110

% error = ____________% for voltage.

7. Calculate the accuracy of your scope for measuring frequency (i.e. time).

$$\%\ \text{error} = \frac{\text{Signal In} - \text{Measured frequency}}{\text{Signal}} \times 100$$

NOTE: Signal In = 120Hz

% error = ____________% for frequency (i.e. time).

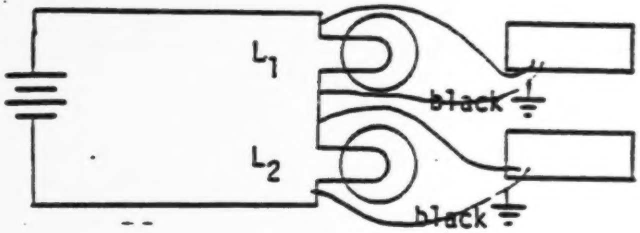
8. Each lab partner should do this project. Compare your results.

PROJECT 3: Working with equipment "common grounds".

INTRODUCTION

Nearly all electronic equipments use the metal case as a "common ground". This means all the cases are electronically the same potential and are connected together through the grounding pin on the A.C. plugs. Because of this, all your coax cables (i.e. "scope leads") used on the Function Generator, Frequency Counter, and Oscilloscope have the black leads electrically connected. That is way you have been directed to insure they are always connected together and to the same point in the circuit. You must NEVER connect the black leads of these cables to two different points in any circuit. If you do, you will have shorted between those two points in that circuit. Here is an example of what happens if two black leads are connected to two different points in a circuit:

Notice that L2 will be shorted and L1 will have the full voltage applied, possibly causing L1 to burn out.



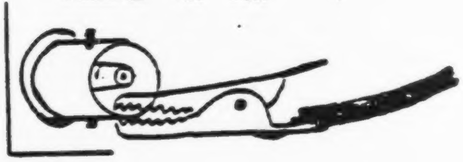
This common ground feature is done for safety reasons and is the practice for most electronic equipment. Some of the VTVM's have the black lead connected to the case and are grounded through the A.C. plug. Those with two prong A.C. plugs don't have this feature. The DMM's and power supplies don't have this common ground feature either. We say they have "floating grounds". Equipment with floating grounds can be connected into the circuit anywhere, and not short between black leads.

In this project you will check the common grounding between your different equipments by using the DMM ohmmeter. This is a good safety practice as an open common ground lead could possibly allow hazardous voltages to develop between different equipments. Touching the metal cases of two un-grounded equipments could be fatal. Never cut the ground pin off of a three prong A.C. plug! This opens the common grounding system between equipments.

INSTRUCTIONS

1. Turn OFF all equipment at your lab bench and leave it OFF throughout this project, except the DMM. Turn the DMM ON and set it to measure ohms.

2. Connect either lead of the DMM to the scope Ch 1 input coax connector as shown below.



3. Touch the other DMM lead to each of the other coax connectors similarly. Between each of the coax connector common ground points you should read 0 ohms.
Do you? YES/NO (If not advise your instructor)

4. Leave one DMM lead connected to the Ch 1 scope coax connector. Touch the other DMM lead to the coax connector on the Frequency Counter.

Do you read 0 ohms? YES/NO

NOTE: You may read a few ohms since now you are measuring through the wires in the A.C. cords and the socket connections.

5. Leave the one lead on the scope common ground point. Use the other DMM lead to check the coax connectors on the Function Generator as well as the terminal marked ⏚.

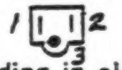
Do you read 0 ohms to each of these points? YES/NO

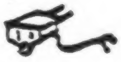
6. Leave the one lead on the scope common ground point. Check the resistance to the Power Supply green terminal marked ⏚. You should read 0 ohms.

7. With the one lead still on the scope common ground, check the resistance to the Power Supply BLACK (i.e. "-") output terminals. You should read infinite ohms since these are floating grounds. They are not connected to the common ground point inside the equipment.

SUMMARY

You should have observed that some electronic equipments have "common grounds" between their cases through the third pin on the A.C. plugs. This is primarily for safety and can prevent electrical shock. Some equipments, like high power audio amplifiers, need common ground connections to minimize "AC hum" and interference. During your career as an electronics technician you may see equipment which has the third pin (i.e. ground pin) on the A.C. plug cut off. This was done by an unwise person trying to use the equipment in an older type two pin AC plug outlet. Cutting off the third pin on an A.C. plug creates a hazard which can cause electrical shock. Should you need to operate a 3-pin plug from a 2-pin outlet, you should use an "adaptor plug" as shown below. These have a third terminal which should be grounded to the building electrical ground system.





There is much more to this subject of common grounding in electrical equipment and buildings than we can cover here. As a technician you should become familiar with this subject and understand both the advantages and problems with common ground systems. In the next project you will learn some of the techniques used to make voltage measurements in a common ground system.

PROJECT 4: Measuring voltages in a series circuit using test equipment with a common ground.

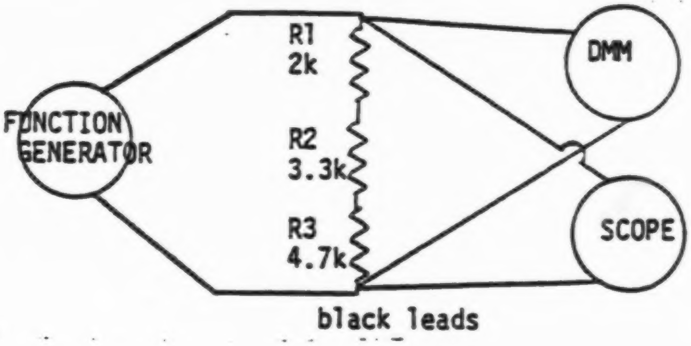
INTRODUCTION

You will now learn some advanced voltage measurement techniques required in modern equipment using common ground systems.

INSTRUCTIONS

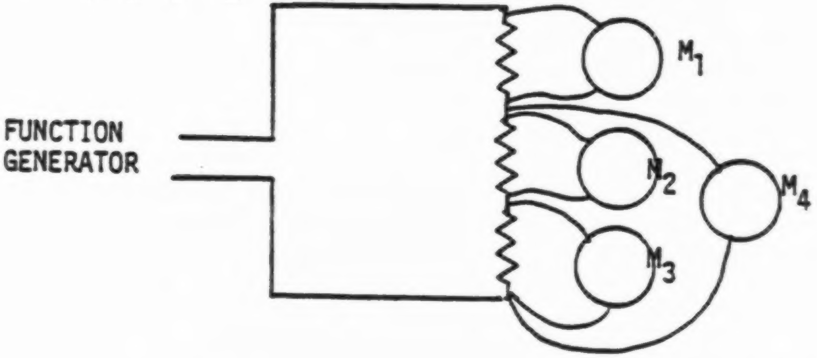
1. Connect the circuit below after measuring the exact resistance value of each resistor. Insure all common ground leads are connected to only one point in the circuit.

R1 (2k):______kohms. R2 (3.3k):______kohms. R3 (4.7k):______kohms.



2. Set the Function Generator for an output sine wave of 1kHz at 3 volts (rms). (Use the DMM to measure voltage.)

3. Calculate the rms voltage drop across each resistor in the circuit. Record the voltage in the "meters" across the resistors.



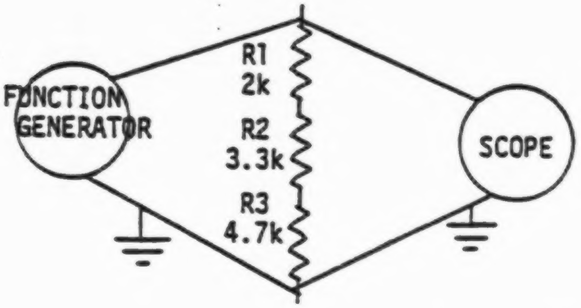
4. Using the DMM, measure and verify the above calculations at each point where a "meter" is indicated. Record below.

M1:_____volts. M2:_____volts. M3:_____volts. M4:_____volts.

Do your measured values agree with the calculated? YES/NO

NOTE: The measured voltage should be the same as the calculated voltage since the DMM has a floating ground which can not short any of the resistors. Next you will use the scope to measure the same voltages. However, because it has a common ground you will get inaccurate measurements. You will learn later how to use special techniques to make accurate measurements when working with common ground circuits.

5. Use the scope to measure the full applied voltage across all three resistors as shown. Be sure the scope and Function Generator black leads are connected to the same electrical point in the circuit. Measure the peak-to-peak voltage and calculate from it the rms voltage. Record:________v(rms).


R1
2k
FUNCTION
GENERATOR
R2
3.3k
R3
4.7k
SCOPE

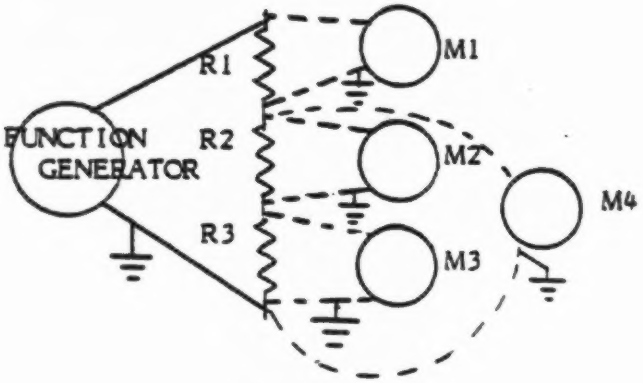
MEASURED:

$E_{R1+R2+R3}$__________v.p-p

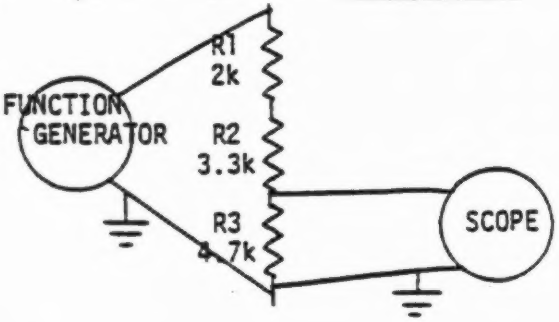
CALCULATED:

$E_{R1+R2+R3}$__________v.rms

6. Use the scope to measure the voltage across each resistor as done with the DMM. Calculate the rms voltage for each measurement made and record below in the appropriate "meters". NOTE: You should not get the same voltage measurements as you did with the DMM because there is now a common ground problem. These measurements made this way are incorrect. Compare them with the values make earlier with the DMM.


R1
M1
FUNCTION
GENERATOR
R2
M2
M4
R3
M3

7. Now you will use a technique which gives you the correct voltage for each resistor. Use the scope to measure the voltage across only R3. Calculate and record the rms voltage:__________v(rms).


R1
2k
FUNCTION
GENERATOR
R2
3.3k
R3
4.7k
SCOPE

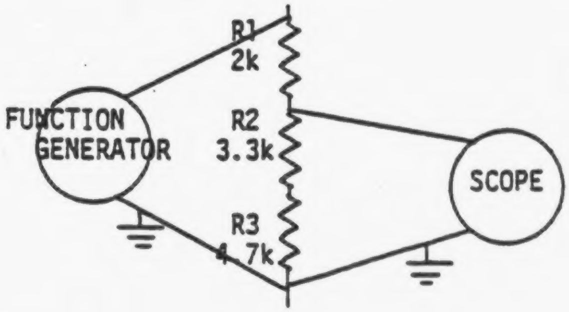
MEASURED:

E_{R3}__________v. p-p

CALCULATED:

E_{R3}__________v.rms

8. Use the scope to measure the voltage across both R3 and R2. Calculate and record the rms voltage:__________v(rms).



MEASURED:
E_{R2+R3} _____v.p-p

CALCULATED:
E_{R2+R3}_________v.rms

9. Calculate the voltage which was across only R2:

$$E_{R2} = E_{R2+R3} - E_{R3} = \_\_\_\_\_\_\_\_ \text{v(rms)}.$$

Does the above value agree with the DMM measured value for E_{R2}?
YES/NO

SUMMARY

You should have observed that when using equipment with common grounds you may need to make some measurements indirectly. In these and future electronic classes you will need to do this often. This should not be a problem for you the remainder of your time in school or on the job if you understand this common ground concept.

PROJECT 5: Measuring DC voltages with the oscilloscope.

INTRODUCTION

Both AC and DC voltages can be measured with a scope. A DC voltage, however, appears as a straight line across the CRT. Positive voltage moves the line up and negative voltage moves it down below an established reference level. Therefore, both polarity voltage values can be measured with the scope. All we need is the reference level and a calibrated graticule. You know your scope is calibrated, so now you will learn to set the reference level. NOTE: These instructions are for the Tektronics 5110 scope but should apply to any good quality scope. However, the names of the controls may be different.

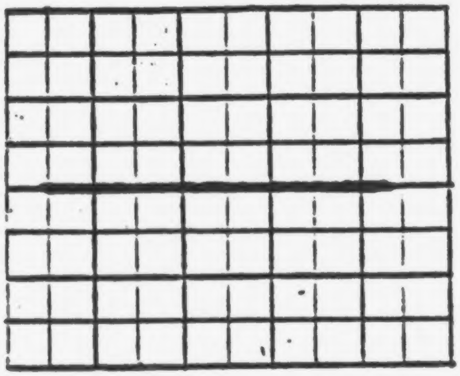
INSTRUCTIONS

1. Locate the scope "AC-DC" button and switch to "DC" (i.e. The "OUT DC" button should be "out").

2. Locate on the scope Vertical Amplifier (near the vertical input jack) the ground button labeled "GND". Push it in.

3. Set the Vertical gain control (v/cm.) to 1v/cm.

4. Use the POSITION control on the Vertical Amplifier to set the trace line on the scope to the center of the graticule as shown below.

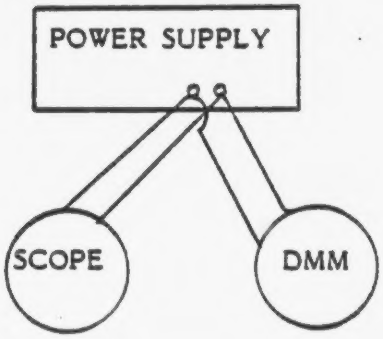


Set trace to center for 0 volt reference.

5. Release the "GND" botton so it is "out". You now have set the scope for zero volts to be read at the center of the graticule. Positive DC input voltages will move the trace up above this point and negative voltages will move it down below it. The voltage can be determined by use of the graticule lines.

6. Turn on the power supply and adjust it to exactly 3 volts using the DMM.

7. Using banana plug leads, connect the power supply 3 volts output to the scope input cable. Connect black lead to black lead and red to red.



You should observe the scope trace move up to a position 3 cm. above the zero reference line.

8. Reverse the polarity of the voltage by switching the red and black leads at the power supply terminals. Observe the trace move to a position 3 cm. below the zero reference line. Change the banana plugs back to the correct polarity.

9. Using the scope to measure DC voltage, adjust the power supply output to each of the voltages shown below. Record the other information indicated in the spaces provided.

Set power supply to voltage below using the DMM.	Scope v/cm. (range)	Scope Deflection Height (cm.)	DC Volts Calculated V = range X height
.5			
1.5			
7.5			
10			
12.5			
16.0			

10. Locate the scope "AC/DC" button and set it for "AC". Try to measure the power supply DC voltage. Can you? YES/NO

SUMMARY

You have been only minimally introduced to the use and operation of the oscilloscope at this point. In your remaining classes you will be expected to use the scope efficiently and effectively. Take every opportunity to practice and study the use of each control on the test equipment.

PART E: SELF-EVALUATION QUIZ

INSTRUCTIONS: Select the correct answer for each statement. Check your responsewith the correct answers at the end of this project.

1. The oscilloscope cathode ray tube (CRT) face can be damaged by adjusting the __________ control too high.

   a. focus b. sweep speed c. brightness d. vertical amplifier attenuator

2. The lines on the face of the CRT used in measuring voltage and time are referred to as the ______________.

   a. video b. graticule c. module d. map

3. A positive voltage applied to the vertical amplifier input causes the sweep to move ____________.

a. up b. down c. left d. right

4. When measuring a DC voltage with the tektronix vertical amplifier which button should be pushed IN on it?

a. DC b. GND c. DISPLAY d. AUTO TRIG

5. The CALIBRATOR output is

a. .120 volts, 400Hz b. .4v,120Hz c. .2v,60Hz d. .4v, 400Hz

6. To set the sweep to a zero reference level in the center of the graticule, you should;

a. push OUT DC button and adjust vertical POSITION
b. push GND button and adjust vertical POSITION
c. push OUT DC BUTTON AND ADJUST VOLTS/DIV
d. push GND button and adjust VOLTS/DIV

7. When measuring voltage with the tektronix vertical amplifier you notice the reading is very inaccurate. The reason could be;

a. DISPLAY button pushed IN
b. GND button pushed IN
c. CAL knob turned CCW
d. VOLTS/DIV knob turned CCW

8. You are using the Tektronics scope to measure a sine wave and the signal is unstable on the CRT. You should do the following to stabalize the scope display:

a. Insure AUTO TRIG button is pushed IN.
b. Adjust Vert. Amp. (v/cm. knob) for highest signal possible on CRT.
c. Adjust LEVEL knob for "lock-in".
d. All the above in that order.

9. The center compartment of the tektronix oscilloscope mainframe can be used to plug-in another vertical amplifier.

a. True b. False

10. The horizontal graticule divisions are used to measure

a. voltage b. amplitude c. time

Answers:

1. c
2. b
3. a
4. c
5. b

6. b
7. c
8. d
9. a
10. c

OSCILLOSCOPE ABBREVIATED TURN-ON PROCEDURE

INSTRUCTIONS

Locate and adjust the following controls to the settings required. Pay particular attention to what each control does as you adjust it. Refer to pages 15 and 16 for drawing. Now turn the POWER swith (#1) ON. While it warms up, preset the following controls for later use.

MAIN CONTROL	LOCATION #	SETTING OR USE
Intensity	2	3/4 clockwise (cw)
HORIZONTAL AMPLIFIER CONTROLS		
Position	6	1/2 cw
Chop/Alt Button	7	out
SWP Mag (sweep magnification)	8	out
CAL (calibrate)	10	Fully cw
Auto Trig (automatic triggering)	11	In
AC Coupl (AC or DC Coupling)	12	Out
Slope (triggers out or slope of sinewave)	13	Out
Singl Swp (single sweep)	14	Out
Reset	15	Out
Level	16	1/2 cw
SOURCE BUTTONS (Trigger Source)		
LEFT	17	In
Right	18	Out
LINE	19	Out
EXT	20	Out

OSCILLOSCOPE ABBREVIATED TURN-ON PROCEDURE

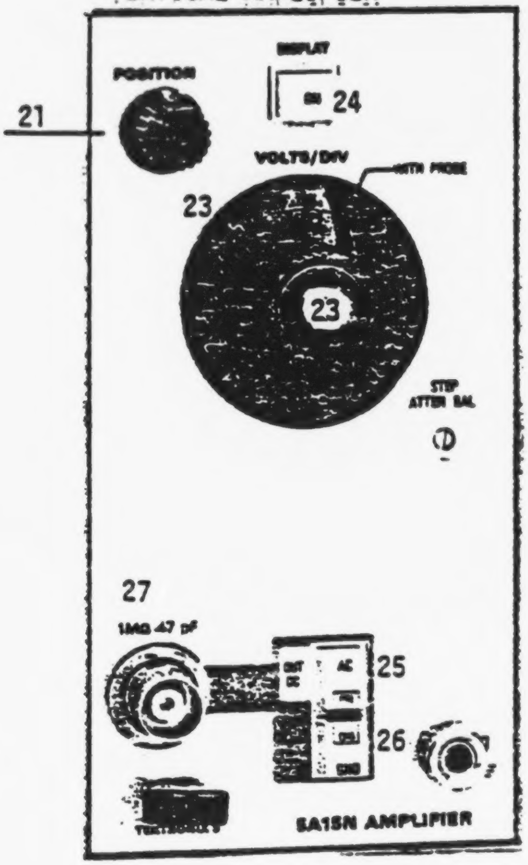
INSTRUCTIONS

VERTICAL AMPLIFIER CONTROLS

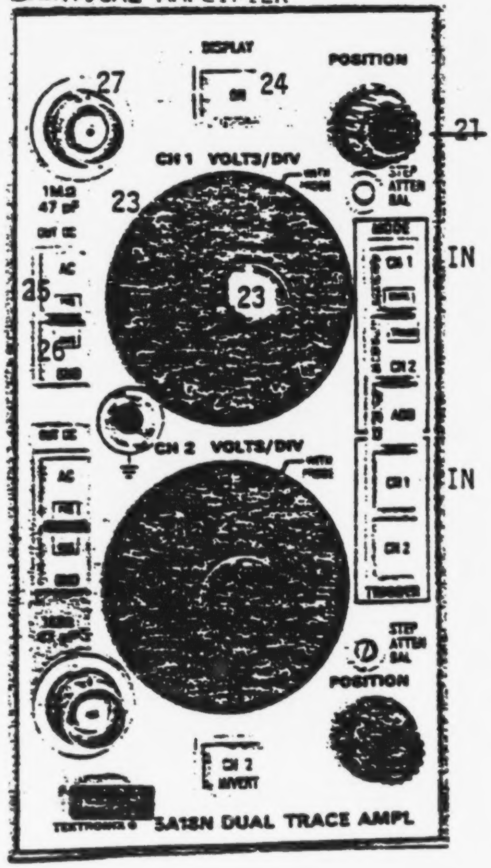
Note: You may have either 2 single channel plug-in modules or 1 double channel plug-in module. The single channel module will be described here. The controls will be similar for the double channel plug-in modules.

POSITION	21	½ CW
VOLTS/DIV	22	1 v/Div
CAL (vertical calibrarion)	23	IN
DISPLAY (display on)	24	IN
AC/OUT DC	25	OUT
GND (ground)	26	OUT
1M 47$_p$F(signal input)	27	connect your scope lead here.

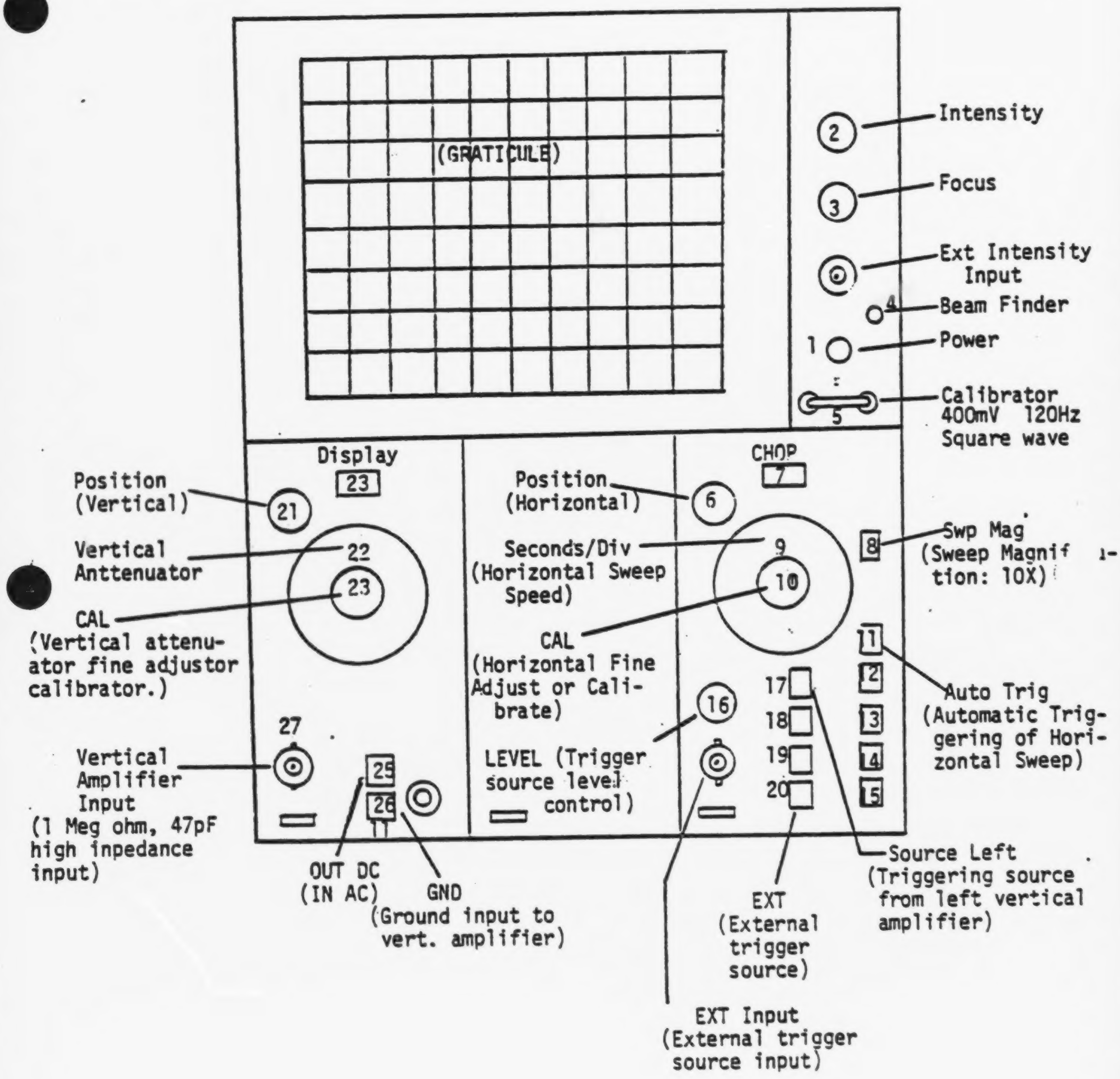
SINGLE CHANNEL VERTICAL AMPLIFIER


21
POSITION
DISPLAY
ON
24
VOLTS/DIV
WITH PROBE
23
23
23
STEP ATTEN BAL
27
1MΩ 47 pF
OUT DC
AC
25
26
GND
TEKTRONIX
5A15N AMPLIFIER

DOUBLE CHANNEL VERTICAL AMPLIFIER


27
DISPLAY
ON
24
POSITION
21
CH 1 VOLTS/DIV
WITH PROBE
1MΩ 47 pF
23
23
STEP ATTEN BAL
OUT DC
AC
25
26
GND
MODE
CH 1
CH 2
ADD
IN
CH 2 VOLTS/DIV
WITH PROBE
CH 1
CH 2
TRIGGER
IN
STEP ATTEN BAL
POSITION
CH 2 INVERT
TEKTRONIX
5A15N DUAL TRACE AMPL

TEKTRONIX 5110 OSCILLOSCOPE


(GRATICULE)
2
Intensity
3
Focus
Ext Intensity Input
4
Beam Finder
1
Power
5
Calibrator 400mV 120Hz Square wave
Display
23
CHOP
7
Position (Vertical)
21
Vertical Anttenuator
22
23
CAL (Vertical attenuator fine adjustor calibrator.)
Position (Horizontal)
6
Seconds/Div (Horizontal Sweep Speed)
9
10
CAL (Horizontal Fine Adjust or Calibrate)
8
Swp Mag (Sweep Magnif
tion: 10X)
11
12
13
14
15
Auto Trig (Automatic Triggering of Horizontal Sweep)
16
LEVEL (Trigger source level control)
17
18
19
20
27
Vertical Amplifier Input (1 Meg ohm, 47pF high inpedance input)
25
26
OUT DC (IN AC)
GND (Ground input to vert. amplifier)
EXT (External trigger source)
Source Left (Triggering source from left vertical amplifier)
EXT Input (External trigger source input)

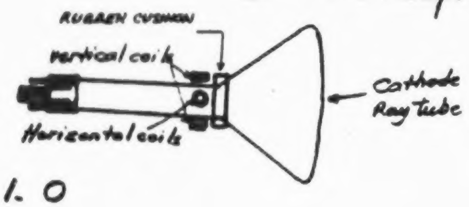
THIS MATERIAL WILL BE INCLUDED LATER

oscilloscope

oscilloscope	:	máy đo dao động.
Audio	:	- âm thanh - về âm thanh
audio generator	:	(máy phâm âm). một bộ phận của máy đo mà nó có tín hiệu phát là sóng hình sine (∿) hoặc sóng vuông (⊓⊔). Tần số phát sóng từ 20 Hz đến 200 KHz
HERTZ	:	Ký hiệu bằng chữ Hz. là đơn vị của Tần số (frequency)
Selectabe	:	có thể chọn lựa
output	:	phát sóng; phát ra; công suất phát.
input	:	nhập lượng; thu nhận vào.
Brightness control	:	hệ thống điều hoà quang độ (sự sáng)

Brightness control còn gọi là bộ phận điều hoà cường độ (in ensity) của nét sóng trên màn ảnh của scope.

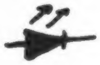
intensity	:	cường độ (độ lớn nhỏ của nét sóng)
Trace	:	vệt, nét của hình sóng.
screen	:	màn ảnh
capacitor checker	:	dụng cụ dùng để thử tụ điện.
shorts	:	mát (chạm)
opens	:	đứt (mở ra)
leaks	:	bị hở (khe hở)
farad value	:	giá trị fa-ra (F). đơn vị của tụ điện là uFarad.
Cathode Ray Tube	:	đèn CRT; đèn của oscillascope.



1. 0

visual	trông thấy
visible	có thể trông thấy.
sweep	quét; di quang.
beam	tia; chùm tia(sáng)
illuminate	chiếu sáng
fluorecent	ánh sáng; huỳnh quang.
atom	nguyên tử
coated	phủ (past)
inner	ở trong
Digital multimeter	một loại máy đo trị số hiện trên màn ảnh để đọc trực tiếp. gọi là DMM.
display	trình bày
digits	số từ 0-9.
fine frequeney adjusment	bộ phận điều hoà vẽ nét của tần số hiện trên màn ảnh của máy dao động.
horizontal	trục ngang; hàng ngang
vertical	trục dọc; hàng dọc.

stabilize	sự chắc chắn.
drifting	chạy trên màn ảnh
Focus	tiêu điểm.
sharp	sắc bén
clear image	hình ảnh trong sáng.
Frequency counter	bộ phận đếm tần số.
gear	dụng cụ
Frequency range control	bộ phận chỉ bậc của tần số. x1, x10, x100.
conjunction	sự nối tiếp; liên tiếp.
dial	vòng số; nút để vặn lớn nhỏ
Function generator	bộ phận có năng lực để cho sóng, độ dốc ... tương tự như function switch.

Sine	sóng hình sin (∿)
triangle	tam giác
ramp	độ dốc
pulse	xung động (tự trồi và sụt bất thình lình của điện thế hay cường độ)
graticule	độ chia trên màn ảnh.
Grip dip meter	một bộ phận dao động làm hòa hợp hình sóng để tạo tần số.
Horizontal gain	bộ phận điều chỉnh tăng chiều dài của một hình sóng.
variable	có thể đổi khác
Horizontal input	bộ phận điều chỉnh tín hiệu cao thấp t ên trục ngang của màn ảnh.
Horizontal positioning	bộ phận điều chỉnh hình sóng. Điều chỉnh sóng di chuyển trên hàng ngang
impedance Bridge	một dụng cụ dùng để xác định điện trở, tích điện, cảm ứng điện, bằng phương pháp so sánh tỷ lệ
ratio	tỷ lệ.
light Emitting diode	đèn âm điện tử. Viết tắt là LED dấu hiệu 
waveshape	hình sóng
waveform	hình sóng
Cathode	âm cực (-)
anode	dương cực (+)
output level control	bộ phận điều chỉnh điện thế hay biên độ phát sóng.
amplitude	biên độ (chiều cao)

probe : bộ phận hay que thử tín hiệu.

Radio frequency generator : (RF) máy phát cao tần. Sóng cao tần từ 150 KHz đến 150 MHz.

mix : pha, trộn lẫn.

audio frequency : âm tần (AF)

transmitter : máy truyền tin.

dummy : phụ, giả.

widerange : bậc rộng, bậc cao

detector circuit : máy dò mạch điện.

internal : bên trong

external : bên ngoài

oscillator : đèn phát sóng đèn dao động

sweep frequency : tần số di quang.

sweep generator : máy di quang

sync amplitude : biên độ đồng bộ. (điều chỉnh tín hiệu vào ăn khớp nhau với sự di quang hàng ngang để giữ

hình sóng đứng yên.

stationary : không đổi.

pattern : kiểu; hình thể.

horizontal sweep : di quang hàng ngang.

Sync : đồng bộ; ăn khớp

synchronization : sự ăn khớp; sự đồng bộ.

Sync selector : một bộ phận như cái công tắc dùng để chọn lựa tín hiệu đồng bộ.

Transistor diode Tester : một bộ phận khảo sát dùng để kiểm lại diode và transistor.

Transistorized VOLTmeter : một loại máy đo dùng mạch biến đổi để điều hòa hành động của máy đo. Viết tắt là : TVM.

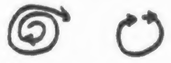
Tube tester	dụng cụ kiểm lại đèn chân không (vacuum tube).
Vacuum tube	
voltmeter	máy đo dùng để đo điện thế, điện trở. Mạch nối của máy đo là đèn chân không. Viết tắt: VTVM.
vertical input	nhập lượng chiều cao (là phần nhập lượng để có chiều cao của sóng khi điện thế được cung cấp).
vertical gain	nút điều chỉnh mà nó điều hòa độ nhảy bén tới vertical input
vertical positioning ↕	nút điều chỉnh độ cao thấp của hình sóng.
VOLT-OHM-METER	một máy đo gồm VOLT-OHM và RESISTANCE VIẾT TẮT: VOM.
manufacture	Sự chế tạo
unfortunately	không may mắn rủi ro.
design (vt)	phác họa
(n)	kiểu, mẫu.
designation (n)	sự phác họa chương trình hành động.
Assume	cho là; giả sử
purchase (n)	sự mua
(vt)	mua
purchasing	việc mua
trouble shooting	rắc rối
failure	khuyết điểm
seperate	tách biệt.
perform	thi hành; làm; diễn.
catalog	một loại sách hàng mẫu.
particular	riêng; đặc biệt.
kit form	hình thức tài liệu.
examing	khảo sát
similar	tương tự

waveform : hình sóng.
At the rear : tại chỗ sau.
rear : chỗ sau
beam : tia sáng
a narrow beam of electrons : tia sóng âm điện tử hẹp
strike : gây nên; tạo ra.
are focused : được làm tiêu điểm
are coated : phủ
inner : bên trong
face : bề mặt; mặt.
internal : bên trong
external : bên ngoài.
input : nhập lường; nhận vào.
output : phát ra.
vertical : chiều cao, đứng; hàng dọc.
Horizontal : chiều dài, nằm, hàng ngang.
roughly : - lởm chởm
- nổi [illegible]
bandwidth : chiều rộng của băng tần.
filter circuit mạch lọc sóng.

sinudolal : sóng hình sin.
square wave : sóng vuông
modulated : được biến điệu.
audio frequency generator : máy phát âm tần (tần số âm thanh)
Radio frequency generator : máy phát sóng vô tuyến.
capable : có khả năng
faulty : sai lầm, lầm lỗi.
stage : sân khấu; trình bày, tầng.
tactic : phép dùng; cách thức dùng
Typical : đặc trưng; đặc biệt.
inject : xen vào
monitor : theo dõi
signal tracer : bộ phận kiểm tín hiệu.
lack : Không có; Thiếu mất
distortion : sự biến dạng.

faulty stage : trình bày sai tầm.
band : băng tần
band switch : công tắc băng tần.
level : bậc
prevent : cản; ngăn chặn
Radiation : sự bức xạ.
versatile : phổ biến.
instrument : dụng cụ.
observe : quan sát
shape , hình, kiểu
phase : biến tướng
intensity : cường độ (sóng).
focus : tiêu điểm.
center the grace : trung tâm
phô diễn.
calibrate : đo
inpact : không thỏa hiệp
pact : thỏa hiệp.
calibration : sự đo
ellipse : hình bầu dục.
pattern : Kiểu
AF : âm tần
RF : cao tần
IF : trung tần
direct probe : máy dò trực tiếp.

brightness : quang độ.
gain : lợi suất
clockwise : quay Theo chiều
Kim đồng hồ.



phosphor : lân tinh.
bright glow : ánh sáng phóng
quang
chemical : hoá phẩm;
hoá học.
destroy : phá huỷ.
clearly visible : hình ảnh
trong sáng.
focusing : điều chỉnh
tiêu điểm
match : xứng bộ
of course : dĩ nhiên.
coax : mơn trớn.
chassis : giàn máy;
khung
precaution : sự đề phòng
familiar : quen thuộc
stable : kiên cố.
stabilize : lâu bền; Kiên cố
concern : quan tâm

stabilizing : sự thăng bằng.
sweep frequency :
tần số quang phổ.
regular : đều đặn.
chỉnh
Coarse : không tốt; to.
recommended : Được dặn dò
Height : chiều cao
Width : chiều rộng
depth : chiều sâu.
reference : sự liên quan;
quan hệ.
sweep Vernier : di quang đứng.
blur : vết bẩn
squeezed : vắt, ép
hesitation : sự do dự.
Braided : đan rối nhau.
application : ứng dụng
disturbe : quấy rối
engraved in : Được khắc trên
plastic plate : đĩa nhựa.
detail : chi tiết
phase relations : liên hệ góc
biến tướng.
phase angle : góc vị tướng;
góc biến tướng.
angle : góc.
quite : hoàn toàn
exist : tồn tại
manner : Kiểu
Ext. Hor : External Horizontal
gain control : Kiểm soát lợi
suất.
substitution : sự thay thế.
temporarily : tạm thời
diagonal : đường chéo.
length : chiều dài.
connect : . nối lại.
+ reconnect
same frequency : cùng tần số.
depend on : tùy thuộc
rotate : quay
stable : chắc chắn
clip : bấm lấy.
suitable : xứng bộ
alligator clip : hàm răng
cá sấu.
isolation : sự biệt lập
duplicate : gấp đôi; hai
lần; bản sao.

LLI-LIIC-12

使用儀表測量 (INSTRUMENTATION)

技術語彙.

audio generator: 音頻发生器.

brightness control: 亮度調節, 亮度控制.

oscilloscope: 示波器, 示波管.

intensity: 強度.

trace: 掃描, 描繪, 軌跡.

screen: 銀幕 屏柵.

leaks: 漏电.

farad value: 法拉值 (电容單位)

cathode: 陰極. [anode 陽極]

cathode ray tube: 陰極射线管.

visual: 可見的. 視覺的.

display: 顯示器. 顯像

sweep: 掃描. 掃掠.

electron beam: 电子束

illuminate: 照明, 點亮.

visible light: 可見光.

oscillator: 振盪器, 斷續器.

fine adjustment: 微調, 細調.

lock in: 鎖, 同步.

drifting: 緩慢流动, 漂浮.

focus: 焦点, 聚焦.

image: 影像.

frequency counter: 頻率計數器

ramp: 等变率 (电流或电压的), 傾斜端頭, 接线夾.

graticule: (测量仪器銀幕上的) 格子线, 或計數线.

grid : 柵[極],網

dip :(磁針的)俯角,(电线的)弛度.

transmitter : 发报机,送話器.

scope : 顯示器,視界.

horizontal gain : 水平增益.(放大).

external : 外来的,外面的,外部的

deflection : 偏轉,偏移,偏斜,撓曲

horizontal deflection : 水平偏轉,行偏轉.

impedance : 阻抗

impedence bridge : 阻抗电橋

ratio-comparative process : 比例比較方法.

light emitting diode : 发光两極管.

dial : 歸碼盤,標度盤,指針盤.
轉歸碼盤以对正波長.

neon lamp indicator : 霓虹燈提示器

oscilloscope : 示波器,示波管.

output level control : 輸出之电压或振幅之控制.

probes : (試)探电極,探針.探示器.

radio-frequency generator : 无线电频率发电机(射频发电机)

sinusoidal : 正弦波的,正弦的

RF : radio frequency . 无线电频率,射频.

dummy load : 仿真負載,等效負荷.

audio : 聲頻.音頻.聲音.聽觉的.

trouble shooting : 故障檢修.故障测查

detector circuit : 檢波器电路

sweep frequency : 掃描頻率

FM : frequency modulation : 調頻.頻率調制.

sweep generator : 掃描振盪器.

sync amplitude : 同步振幅.

sync = synchronous 同步的.

mode : 形式 表現方法.

LII-U1C-14, ·23.

transistor-diode：晶体(三極)管一二極管

gain：獲得，增益.

transistorized voltmeter＝晶体管(化)伏特計（TVM）

triggered sweep：觸发掃描.

vacuum tubes＝真空管

vertical gain：垂直增益.

deflect：偏轉，偏斜，偏離，撓曲.

designation：命名，名稱

attenuator：減衰器.

AF：audio frequency 音頻

RF：radio frequency 无线电频率

peak：最高尖，波峰，巔值.

timing circuit：定時电路，計時电路

CRT：cathode-ray tube

electron gun：电子槍

phosphor atoms：磷 原子

inner face：内部表面.

internal circuitry：内电路

horizontal：水平，横相.

vertical：垂直，縱相.

external input：外部輸入

isolate：隔離，孤立，绝缘.

distortion：畸变，失真.

handwidth 通帶寬度，頻帶寬度.

filter circuit：濾波(器)电路.

phase relationships：相位关係.

modulated：已調(制)的，受調的.

inductor：感應器，感應线圈

tactic 節拍的

monitor：監聽器，監控器.

faulty：发生事故的，有故障的，有缺陷的

shielded：屏蔽的，隔離的

-5.-7.-9.-10-11.
LII-1110-24.-25.

prevent : 防止

alignment : 校準, 調整, 調準.

tuned : 已調諧的

versatile : 多用途的, 多功能的.

grace : [印錯了, 应該是 trace]

inpact : 〔印錯了、应該是 input)

Lissajous patterns : 利薩如图形

ellipse : 椭圓(形)

figures : 图形

IF : intermediate frequency 中频率.

centering : 定中心調整, 定圓心

dot : 點,

HOR = horizontal = H 水平, 横相

intensity control : 亮度調整, 強度控制.

sharp : 銳, 鮮明

GND = ground . 接地, 地线, 地

banana jacks and plugs : 香蕉型插
及插頭

microphone : 传話器, 传声器, 微音器.

co-ax 同軸

BNC = 一种儀器上使用的快速接連插頭

stabilize : 穩定.

waveform 波形

blurred : 朦朧的, 模糊不明顯.

theory : 理論

coarse : 粗的, 粗糙的, 鈍的

vernier : 游標, 游標尺.

integral multiple : 整体的複式(重複

braid : 编带, 飾带.

complex waveform : 複數波形.

stage : 級, 程度, 階段

shift : 移动, 位移.

substitution box : 代替盒(箱).

-22, -23
-17, -18, -2
-12, -13. -14. -15. -16.

diagonal straight line：对角直线

disturb：干擾

time interval 時间间隔，间隔時间.

magnification 放大，增強，放大率

magnifier 放大器，放大鏡 = MAG.

reciprocal：倒數，相反的.

period：週期，循環，期间

hum：[發]嗡嗡声，[發]蜂音，[交流]哼声

capacitance compensation：电容補償.

duplicate：双重，複製.

under compensated：補償不足

over compensated：補償过多.

high impedance 高阻抗

demodulation：解調，反調制

modulation envelope：調制波形的上下範圍謂之.

5